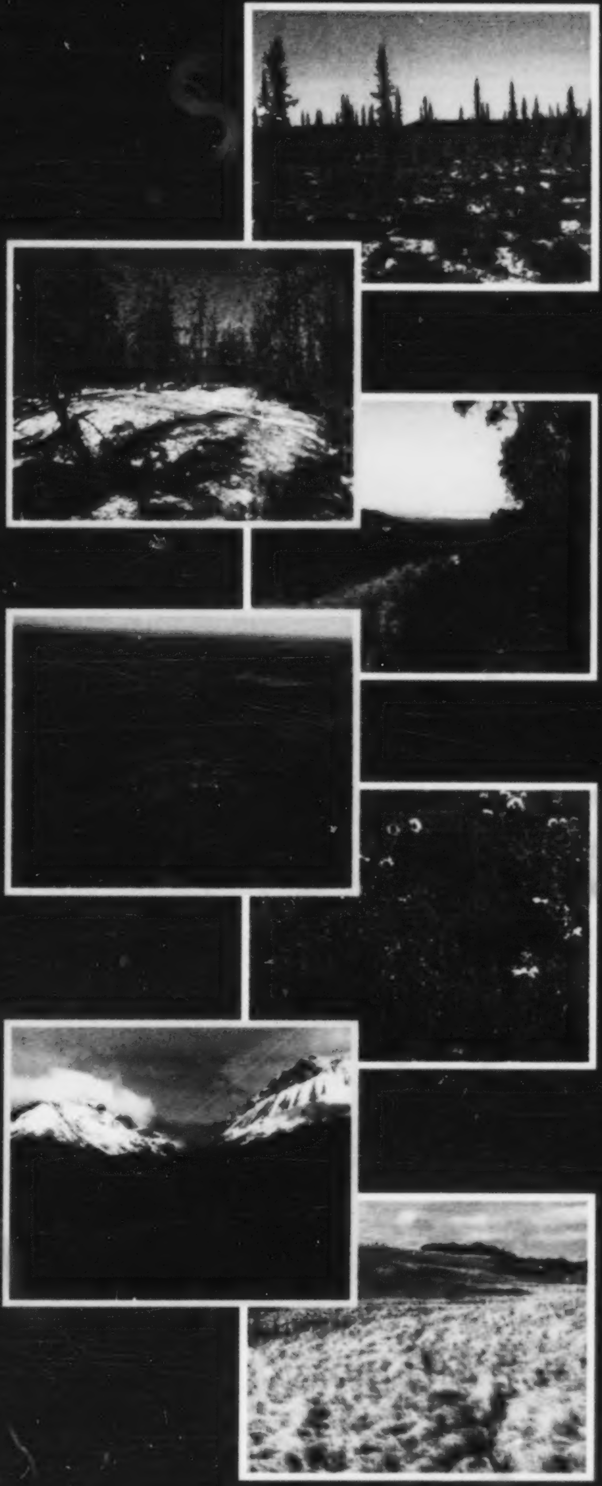
Natural Regions and Subregions of Alberta

Natural
Region
Committee

2006



2007-00091

NATURAL REGIONS AND SUBREGIONS OF ALBERTA

Natural Regions Committee

Compiled by

D.J. Downing and W.W. Pettapiece

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PREFACE

The Province of Alberta includes some of the most diverse terrain in North America. Mountains, foothills and plains temper regional climates, the intensity of solar radiation decreases markedly from the 49th to the 60th parallel, and regional landscapes transform solar and climatic influences to produce an intricate ecological complex.

Plant communities and soil patterns provide, in part, the evidence for delineating the climatic and physiographic patterns which control vegetation and soil distribution. Both the plant communities and soils develop in response to *abiotic factors*, and *biotic factors*.

The relative influence of each factor at any place in the landscape is determined by the interaction of atmospheric and landscape attributes—climate, topography, parent materials and biotic elements—all acting over time, as described by Major (1951) and Jenny (1941) for vegetation and soils, respectively. These attributes can be delineated and represented as abstract ecological map units, and may be described at various scales.

At the global scale, the *Biome* or *Vegetation Zone* is recognized (Walter 1979; Scott 1995). At the national scale in Canada, *Ecozones*, *Ecoregions* and *Ecodistricts* are described (Ecological Stratification Working Group 1995). In Alberta, *Natural Regions* and *Natural Subregions* constitute the broadest levels of ecologically based landscape classification.

The value of regional ecological land classification systems as a foundation for sustainable resource management has been recognized for at least four decades in Canada. These systems provide a means of presenting and understanding biophysical patterns in a geographic context, and a common basis for communication.

In Alberta, Natural Regions and Natural Subregions have supplied the provincial ecological context within which resource management activities have been planned and implemented since the 1970s. Examples of these activities include regional to local integrated resource plans, protected areas program plans based on Natural Subregion themes, numerous forest and range inventory and analysis systems nested within Natural Subregions, and provincial state of the environment reports at the Natural Region level.

This document presents the climatic, physiographic, vegetation, soil, wildlife and land use attributes that characterize each Natural Region and Subregion. It has been organized into four parts, and presented in a format that is suitable for both technical and non-technical users.

- Part 1 outlines Natural Region and Subregion concepts, gives an overview of major Alberta climatic patterns, and provides a review of the revision process and a comparison of past and current Alberta ecological land classifications in the provincial and national context.
- Part 2 describes methods used to generate climate statistics.
- Part 3 presents a comparative analysis of selected climate statistics to facilitate comparison of Natural Regions and Subregions.
- Part 4 presents detailed climatic, vegetation, soils and physiographic descriptions for 6 Natural Regions and 21 Natural Subregions currently recognized in Alberta.

The document concludes with a list of cited references, common and scientific names (Appendix 1), detailed climate statistics (Appendix 2), a glossary of terms (Appendix 3), and summaries of parent materials, landscape elements and soil type occurrences by Natural Region and Subregion (Appendices 4–7). (Note: italicized terms within the document are defined in the glossary.)

Accompanying this document is the Natural Regions and Subregions map, which details the current Natural Region and Subregion classification.

This document is a revision of the previously published Natural Region and Subregion as well as Ecoregion classifications for Alberta. This includes:

- *Natural Regions and Subregions of Alberta: Summary* (Alberta Environmental Protection 1994);
- the classification presented in *Natural Regions, Subregions and Natural History Themes of Alberta* (Achuff, P.L. 1994); and
- the *Ecoregions of Alberta* reports (Strong, W.L. and Leggat K.R. 1992 and 1981).

Ecodistricts of Alberta (Strong and Thompson, 1995) has not been revised to reflect the revisions made in this classification.

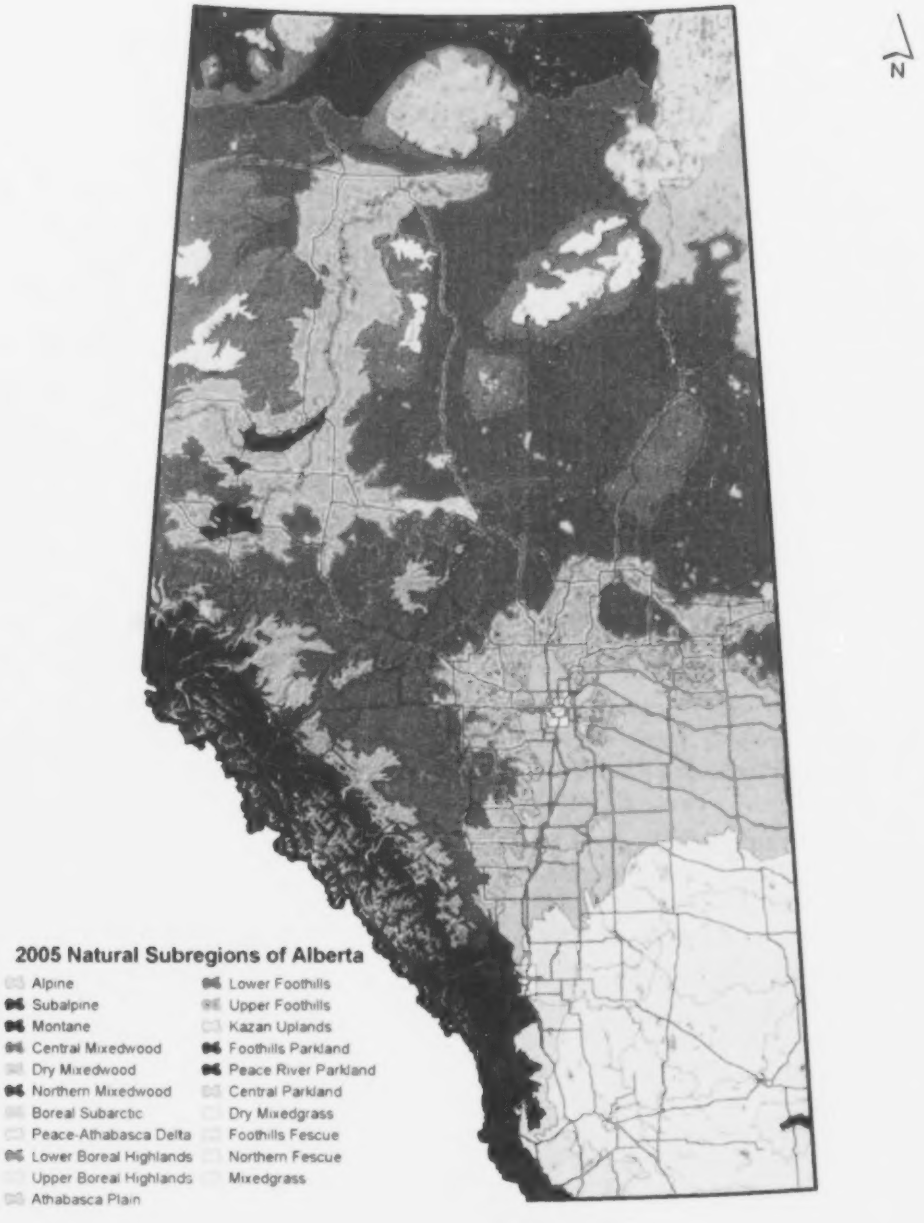

N
2005 Natural Subregions of Alberta
Alpine
Subalpine
Montane
Central Mixedwood
Dry Mixedwood
Northern Mixedwood
Boreal Subarctic
Peace-Athabasca Delta
Lower Boreal Highlands
Upper Boreal Highlands
Athabasca Plain
Lower Foothills
Upper Foothills
Kazan Uplands
Foothills Parkland
Peace River Parkland
Central Parkland
Dry Mixedgrass
Foothills Fescue
Northern Fescue
Mixedgrass

Figure 1-1. Natural Subregions of Alberta.

PART 1. CONCEPTS, CLIMATES AND MAPPING SYSTEMS

1.1 CONCEPTS

Natural Regions are the largest mapped ecological units in Alberta's classification system. They are defined geographically on the basis of landscape patterns, notably vegetation, soils and physiographic features. The combined influence of climate, topography and geology is reflected by the distribution of these features (Achuff 1994, Marshall et al. 1996). Wildlife distribution patterns, and particularly certain species that favor specific habitats, are sometimes useful in delineating Natural Regions. Land use patterns may also be helpful, as human activities respond to climatic and parent material influences.

There are six Natural Regions, which are described in Parts 3 and 4 and also listed in Table 1-1. The degree to which climate, physiography, vegetation and soils define a particular Natural Region depends on its geographic location. Soils and climate tend to be most important in the southeastern plains; elevation, topography and vegetation are most important along the foothills and mountains; latitude, physiography and vegetation are most important in the northern plains and forests.

Topography and elevation are significant factors in the Rocky Mountain Natural Region.
(Photo: T. Kobliuk)

Natural Subregions are subdivisions of a Natural Region, generally characterized by vegetation, climate, elevation, and latitudinal or physiographic differences within a given Region. For example, the Rocky Mountain Natural Region is divided into three Natural Subregions:

1. the cold, wet and treeless Alpine Natural Subregion at the highest elevations;
2. the somewhat more moderate climate of the forested Subalpine Natural Subregion at middle elevations in the Rocky Mountains;
3. the warmer, drier, forest–grassland complexes of the Montane Natural Subregion in the valleys and along the lower slopes and foothills of the Front Ranges.

There are 21 Natural Subregions. In Parts 3 and 4 and in Table 1-1, the Subregions are listed under the Natural Region to which they belong. The Natural Regions and Subregions map shows the geographic extent and location of each Natural Region and Subregion.

Table 1-1. Natural Regions and Subregions of Alberta.

NATURAL REGION	NATURAL SUBREGION
Rocky Mountain	Alpine Subalpine Montane
Foothills	Upper Foothills Lower Foothills
Grassland	Dry Mixedgrass Mixedgrass Northern Fescue Foothills Fescue
Parkland	Foothills Parkland Central Parkland Peace River Parkland
Boreal Forest	Dry Mixedwood Central Mixedwood Lower Boreal Highlands Upper Boreal Highlands Athabasca Plain Peace-Athabasca Delta Northern Mixedwood Boreal Subarctic
Canadian Shield	Kazan Upland

The *reference site* is the vegetation–soil combination that represents the central concept of a Natural Region or Natural Subregion. It is useful for concisely describing the distinctive characteristics of a Natural Region or Natural Subregion. A *reference site* is conventionally regarded as a site with "deep, well to moderately well drained, medium textured soils, with neither a lack nor an excess of soil nutrients or moisture, and neither exposed nor protected from climatic extremes" (Strong and Leggat 1992; Ecoregions Working Group 1989).

Sites meeting these criteria are considered to reflect the regional climate. For example, in the Central Mixedwood Natural Subregion, a reference site would be associated with aspen and aspen–white spruce stands on deep, moderately fine-textured soils of average moisture and nutrient status.

Because Natural Regions and Subregions are characterized by different influences depending on geographic location, this concept of reference site does not always fit well with the most commonly occurring soil–vegetation combination. For example, in the bedrock-dominated Kazan Upland Natural Subregion in far northeastern Alberta, deep, medium textured soils are uncommon. The most commonly occurring vegetation and soil combination there is pure or mixed stands of jack pine and aspen in pockets of sandy materials in a bedrock-dominated landscape.

Jack pine and aspen in a bedrock-dominated landscape. (Photo: D. Vujnovic)

Such *characteristic sites* are the combination of plant community and/or soil type that best typifies the overall climatic and physiographic features of a given Natural Subregion. Reference sites are also considered characteristic sites where the reference site concept fits typical community–soil combinations; for example, in the Central Mixedwood the reference site (aspen or mixedwoods on average sites) is also the most commonly occurring upland type (characteristic).

Descriptions of the Natural Subregions are provided in Part 4. Where the most commonly occurring vegetation–soil combination does not match well with the reference site concept, both the reference sites and characteristic sites are presented.

1.2 CLIMATES

Three major climatic regimes occur within Alberta. These are referred to as the Grassland, Boreal and Cordilleran ecoclimatic provinces (Strong and Leggat 1992; Ecoregions Working Group 1989). Although they are not a part of the Natural Region and Subregion mapping framework, an overview of annual and seasonal temperature, precipitation and insolation patterns helps provide a better understanding of the influence of elevation, latitude and hemispheric airflow patterns on Natural Region and Subregion distribution.

Table 1-2 compares the three ecoclimatic provinces on various criteria and lists those Natural Regions that are most closely related. This information is summarized from text descriptions in Strong and Leggat (1992). Figure 3-1 and the accompanying discussion in Part 3 provides a further description of the relationship between provincial climates and Natural Regions.

Temperature and precipitation regimes in Alberta are determined by the interaction of major air masses.[1] There are four common air masses — the maritime polar, continental polar, maritime tropical and continental arctic. Usually only two of these occur at any one time. Their interaction produces both region-wide and local seasonal weather patterns.

---

[1] *Information on seasonal weather patterns was provided by Alberta Agriculture (http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all)*

Winter weather patterns are dominated by the maritime and continental polar air masses.

- The maritime polar air mass from the north Pacific is moist, producing heavy snowfalls at higher elevations in the mountains and lesser amounts along the lee side of the Front Ranges, the foothills and the plains to the east.
- The continental polar mass, which forms over Canada's interior, is dry and cold, and snowfall amounts tend to be much less. Occasional outbreaks of extreme cold weather occur from continental arctic fronts that originate in the Yukon and Northwest Territories.
- Chinooks are characterized by a rapid rise in temperature and strong, drying winds. These are a climatic feature typical of southern Alberta and may occur when a high pressure system off the British Columbia coast is accompanied by a low pressure system on the lee side of the Rocky Mountains.

Summer weather patterns are also influenced by maritime and continental polar air masses. The maritime tropical air masses from the Gulf of Mexico and from the Pacific sometimes enter Alberta, often bringing significant moisture that frequently produces convective storms accompanied by heavy rains, lightning and occasionally severe weather (hailstorms, damaging winds and tornadoes).

Summer storms are frequent. (Photo: L. Allen)

Table 1-2. Climatic characteristics of ecoclimatic provinces within Alberta.

Distinguishing Characteristic	**Ecoclimatic Province**		
	Grassland	***Boreal***	***Cordilleran***
Climate type	Continental	Continental	Cordilleran
Temperature regimes	Cold winters, short hot summers; July is warmest month. Mean annual temperature approx. +3°C.	Cold winters, short warm summers, July is warmest month, mean annual temperatures +0.5°C.	Cold winters, very short cool summers, mean annual temperatures approximately –0.5°C.
Precipitation patterns	Summer-high (June), low annual precipitation (average 410 mm).	Summer-high (July), moderate annual precipitation, increases with elevation (foothills); variable annual precipitation (average 480 mm).	Variable due to aspect and elevation; high relative to other ecoclimatic provinces; higher at high elevations and on west and north aspects. Relatively high annual precipitation (average 800 mm).
Relative insolation	Relatively high; the highest solar inputs are in southerly latitudes (4600-4800+MJ/m^2 annually)[1].	Decreases with latitude (4600 MJ/m^2 annually in the south to less than 4200 MJ/m^2 annually near 60° latitude).	Controlled by latitude and aspect; higher on south- and west-facing slopes, also decreases with increasing latitude.
Growing season	May–September	May–September (June–August at higher latitudes).	June–August.
Moisture availability in growing season	Generally limiting to growth after June; high evaporation due to high insolation, drying westerly winds. Availability increases with elevation (higher precipitation) and latitude (lower solar inputs).	Precipitation is only slightly higher than the Grassland Ecoprovince. Because temperatures are lower, evaporation is reduced and available moisture is higher than in the grasslands.	May be limiting on southerly aspects with thin soils at high elevations or lower elevation locales, but generally not limiting (except in the Montane Natural Subregion as a result of lower precipitation and exposure to drying winds or alpine ridges that are swept clear of snow in the winter and exposed to drying winds in summer).
Important airflow patterns	Cold northerly flows in winter. Also, milder Pacific air masses in winter produce higher temperatures in elevated areas to the west, with chinooks mainly in southwest Alberta.	Cold, dry Arctic air masses dominate in winter and spring; westerly flows from the Pacific bring moisture in summer.	Prevailing westerlies (Pacific moisture) and continental airflows from the north and southeast are the dominant influences.
Natural Regions and Subregions	Grassland Natural Region, Parkland Natural Region (transitional between Boreal and Grassland).	Boreal Forest Natural Region, Canadian Shield Natural Region, Foothills Natural Region (transitional between Boreal and Cordilleran).	Rocky Mountain Natural Region.

[1]. *Insolation data from Alberta Agriculture (1971-2000)*

1.3 PROVINCE-WIDE ECOLOGICAL MAPPING SYSTEMS

1.3.1 History

Since the 1930s, ecologists have worked toward providing a better understanding of provincial vegetation patterns and their linkage to environmental factors. In forested areas, Halliday (1937) and Rowe (1972) produced national cover classifications that related general climatic conditions and forest types across Canada, including the forested areas of northern and western Alberta. North (1976) developed a vegetation map and accompanying descriptive report for the entire province.

The first province-wide integration of climate, physiography, soils and vegetation was completed in 1977 for Natural Area and Ecological Reserve planning purposes (Achuff and Wallis 1977, revised 1994). It was followed in 1981 by the publication of Ecoregions of Alberta (Strong and Leggat 1981, revised 1992), which provided a framework for subsequent integrated resource planning. Knapik and Westworth (1984) presented a similar approach in support of provincial wildlife habitat classification.

In 1994, elements of the Ecoregions and Natural Subregions approaches were combined to produce the Natural Regions and Subregions of Alberta (Alberta Environmental Protection 1994). At the national level, work on Ecozones, Ecoregions and Soil Landscape Units occurred concurrently through the 1980s and 1990s (Ecological Stratification Working Group 1995). Both the federal and provincial governments have focused on integrating the national and provincial classification schemes.

Table 1-3 shows the relationship between the 1992 Ecoregions of Alberta, the 1994 Alberta Natural Regions and Subregions document, the 1996 national Ecozones and Ecoregion system, and the 2006 Natural Regions and Subregions presented in this report.

1.3.2 Revisions to the 1994 Alberta Natural Regions and Subregions Classification System

Improved ecological knowledge throughout the province, interest expressed by various public and private sector stakeholders, and changes to the national soil landscape classification led to the need to revise the 1994 Natural Regions and Subregions classification. In late 2000, a review committee began refining and updating the 1994 classification system. This committee included representatives from Alberta Environment, Alberta Sustainable Resource Development, Alberta Community Development and Agriculture and Agri-Food Canada.

The revision process was facilitated by the availability of better algorithms for climate modeling coupled with improved GIS systems and better digital data. Between 2000 and 2004, the committee gathered and reviewed available data and used this information to develop a draft revised Natural Region and Subregion map.

A public workshop was held in October 2004 to present the draft version of the map, the methods used to construct it and summaries of the Natural Subregion characteristics. Subsequent comments by technical experts and stakeholders were incorporated, and climate data were finalized based on minor area revisions.

The 2006 classification is the best approximation of province-wide biophysical patterns given the climatic and biophysical information available to date. It is based partly on 1961–1990 climate normals that may or may not be representative of future trends. It is likely that current provincial ecological classification concepts will change in response to new information, improved analytic techniques and changes in global-to-local climates. This document and the accompanying map will provide both a framework for current resource management and a benchmark against which broad landscape changes can be assessed.

Table 1-3. Comparison of provincial and national ecological land classification systems.
(Sums at bottom of table are total number of units recognized at each classification level.)

Grassland (Prairie)	Dry Mixed Grass Mixed Grass Fescue	Dry Mixedgrass Mixedgrass Foothills Fescue Northern Fescue	Grassland	Dry Mixed Grass Mixed Grass Foothills Fescue Northern Fescue	Grassland	Prairie	Mixed Grassland Moist mixed Grassland Fescue Grassland (Cypress Upland) Aspen Parkland
	Aspen Parkland	Central Parkland Foothills Parkland Peace River Parkland	Parkland	Central Parkland Foothills Parkland Peace River Parkland	Parkland		
Boreal	Low Boreal	Dry Mixedwood	Boreal Forest	Dry Mixedwood	Boreal Forest	Boreal Plain	Boreal Transition, Peace Lowland
	Mid Boreal	Central Mixedwood Peace River Lowlands Wetlands Mixedwood		Central Mixedwood Peace-Athabasca Delta Northern Mixedwood Lower Boreal Highlands		Taiga Plain Boreal Plain	Slave River, Wabasca Lowlands Hay River Lowland Mid-Boreal Uplands
	High Boreal	Boreal Highlands		Upper Boreal Highlands			
	Boreal Subarctic	Sub-arctic Mixedwood		Boreal Subarctic		Taiga Plain	Northern Alberta Uplands
	High Boreal	Athabasca Plain Kazan Upland	Canadian Shield	Athabasca Plain		Boreal Shield	Athabasca Plain
				Kazan Upland	Canadian Shield	Taiga Shield	Tazin Lake Upland
	Lower Boreal-Cordilleran Upper Boreal-Cordilleran	Lower Foothills Upper Foothills	Foothills	Lower Foothills Upper Foothills	Foothills	Boreal Plain	Western Alberta Upland
Cordilleran	Montane Subalpine Alpine	Montane Subalpine Alpine	Rocky Mountains	Montane Subalpine Alpine	Rocky Mountains	Montane Cordillera	Eastern Continental Ranges, Northern Continental Divide
3	13	20	6	21	6	6	17

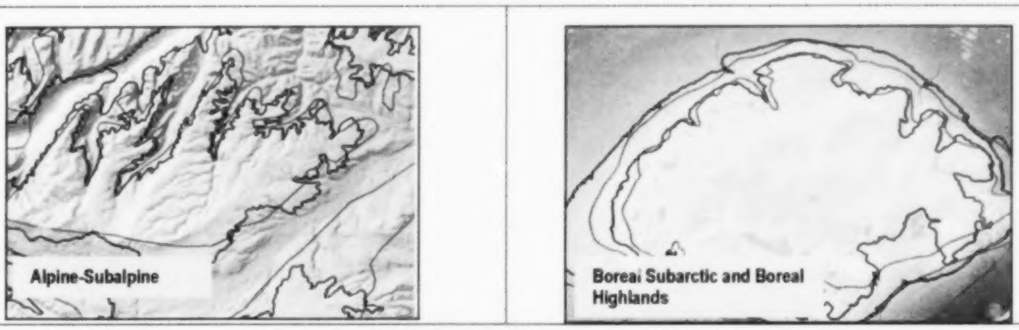
Heavy horizontal lines are ecoprovince boundaries. Light horizontal lines are natural subregion boundaries. Dashed horizontal lines indicate approximately equivalent units across systems (e.g., 1992 Low Boreal ecoregion includes 1994 and 2005 Peace River Parkland and Dry Mixedwood Natural Subregions)

1.3.3 Differences Between the 1994 and 2006 Classifications

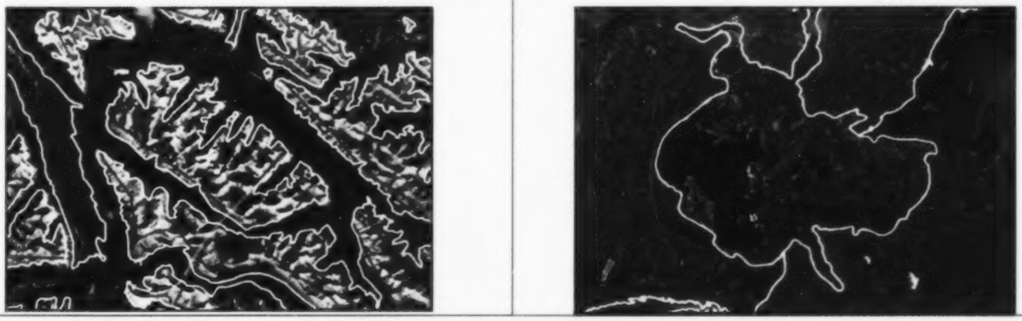
There are two primary differences between the 1994 and 2006 versions of the provincial ELC framework:

1. The first is a change in mapping concepts due in part to improved digital information and good visual presentations of various vegetation, soils and climatic trends at the provincial scale.
2. The second is a change in the level of detail to which polygon lines are drawn. In 1994 and earlier versions, line work was generalized to a scale of approximately 1:1,000,000; the mapping scale for the current iteration was 1:250,000 and polygons were often mapped to contour lines, giving a very high level of detail.

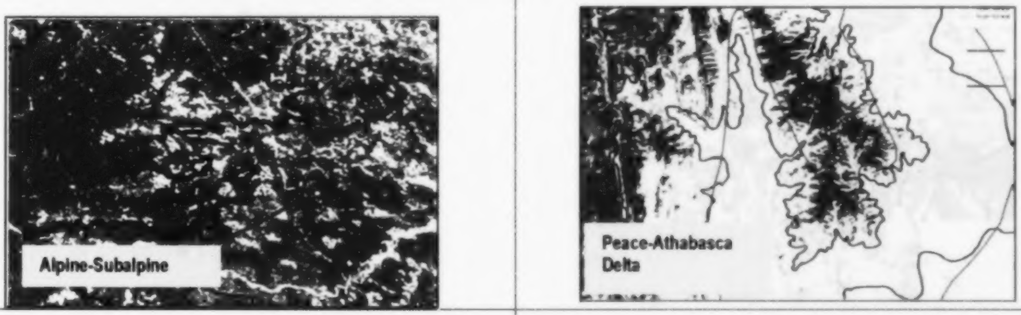
Table 1-4 summarizes the main differences between the 1994 and 2006 Natural Region and Subregion classifications. "Significant" changes are those where major re-assignments of Natural Subregion areas or changes in concept occurred. The most significant changes occurred to the Boreal Forest and Rocky Mountain Natural Regions. Figure 1-1 shows examples of line work differences between the 1994 and 2006 classifications. Figure 1-2 shows the major physiographic regions referred to in Table 1-4 and throughout the document. Figure 1-3 indicates the location of important topographic and hydrologic features within Alberta.


Alpine-Subalpine
Boreal Subarctic and Boreal Highlands

Detailed 2006 (black) lines based on contour information vs. 1994 (red) lines based on general 1:1,000,000 interpretation.



Detailed 2006 (white) lines based on Landsat imagery vs. 1994 (red) lines based on general 1:1,000,000 interpretation.


Alpine-Subalpine
Peace-Athabasca Delta

Detailed 2006 (black) lines and general 1994 (red) lines overlaid on forest inventory; darker green is lodgepole pine, lines are Upper Foothills- Lower Foothills interface.

Detailed 2006 (black) lines and general 1994 (red) lines overlaid on recent forest inventory; purple is Douglas fir forest, lines are Montane- Foothills Fescue interface.

Figure 1-2. Examples of differences in mapping detail between 1994 and 2006 classification.

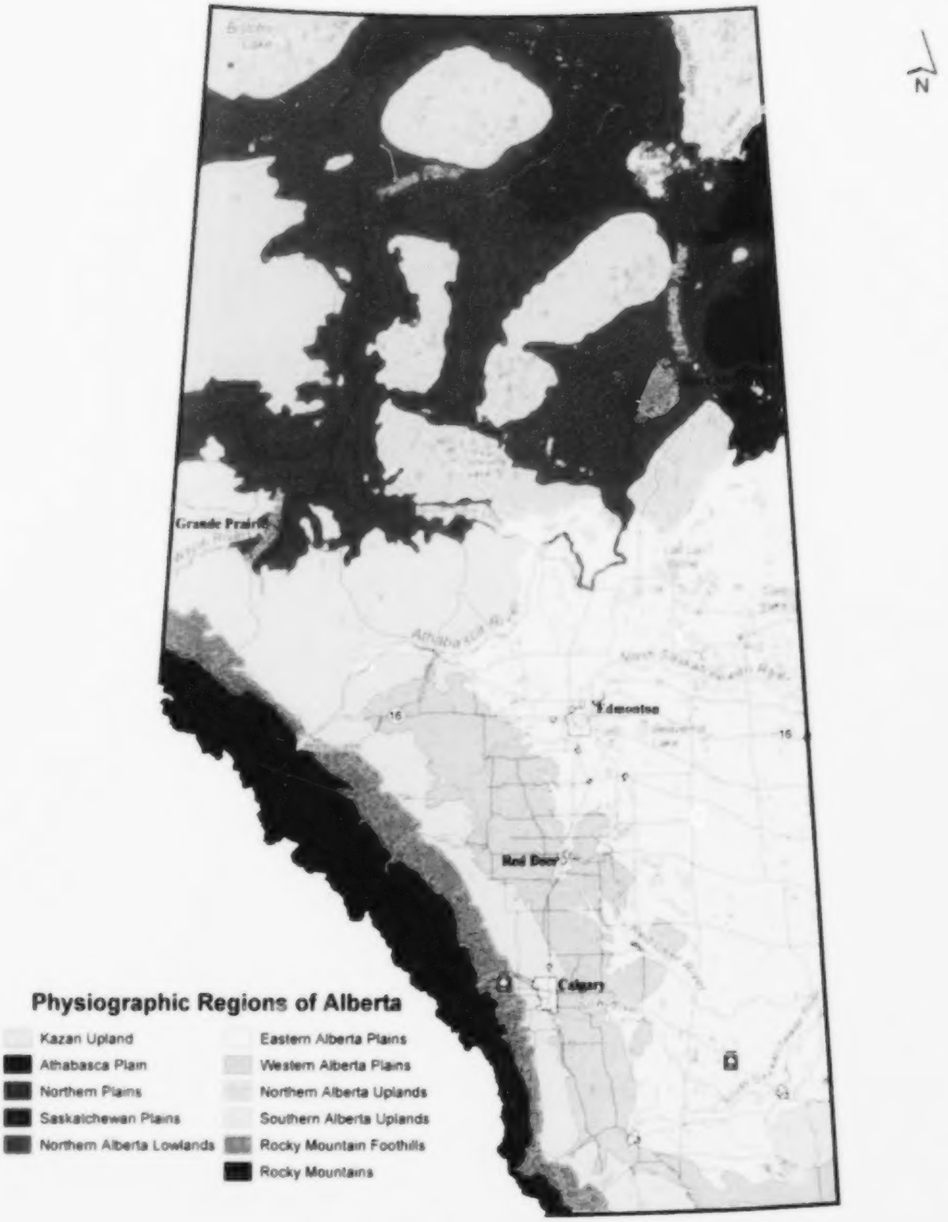

N
Grande Prairie
Athabasca River
North Saskatchewan River
Edmonton
16
16
Red Deer
Calgary
Physiographic Regions of Alberta
Kazan Upland
Athabasca Plain
Northern Plains
Saskatchewan Plains
Northern Alberta Lowlands
Eastern Alberta Plains
Western Alberta Plains
Northern Alberta Uplands
Southern Alberta Uplands
Rocky Mountain Foothills
Rocky Mountains

Figure 1-3. Physiographic Regions of Alberta.

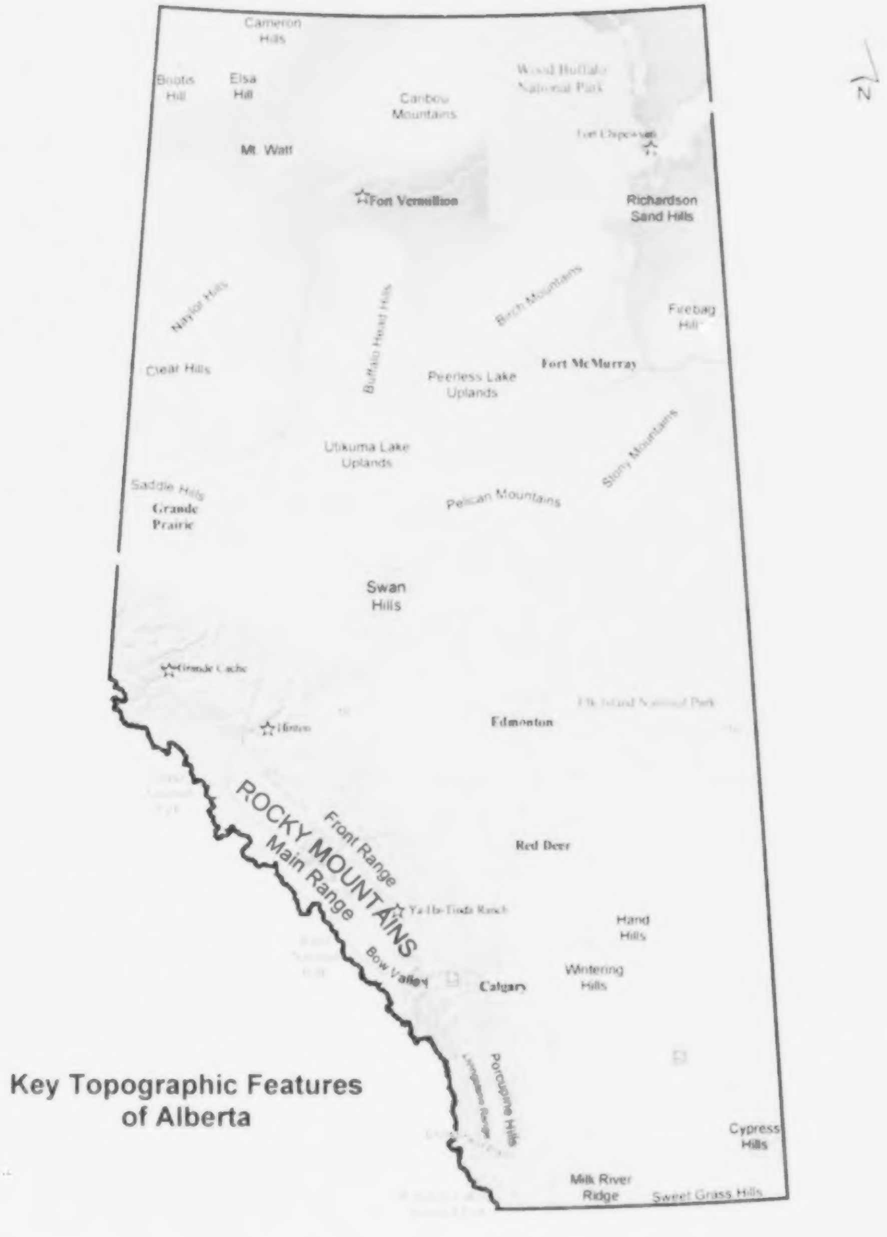

Cameron Hills
Bootis Hill
Elsa Hill
Wood Buffalo National Park
Caribou Mountains
Fort Chipewyan
Mt. Watt
Fort Vermilion
Richardson Sand Hills
Naylor Hills
Buffalo Head Hills
Birch Mountains
Firebag Hills
Clear Hills
Peerless Lake Uplands
Fort McMurray
Utikuma Lake Uplands
Stony Mountains
Saddle Hills
Grande Prairie
Pelican Mountains
Swan Hills
Grande Cache
Hinton
Edmonton
Elk Island National Park
ROCKY MOUNTAINS
Front Range
Main Range
Red Deer
Ya-Ha-Tinda Ranch
Hand Hills
Bow Valley
Calgary
Wintering Hills
Porcupine Hills
Livingstone Range
Cypress Hills
Milk River Ridge
Sweet Grass Hills
N
Key Topographic Features of Alberta

Figure 1-4. Key topographic features of Alberta.

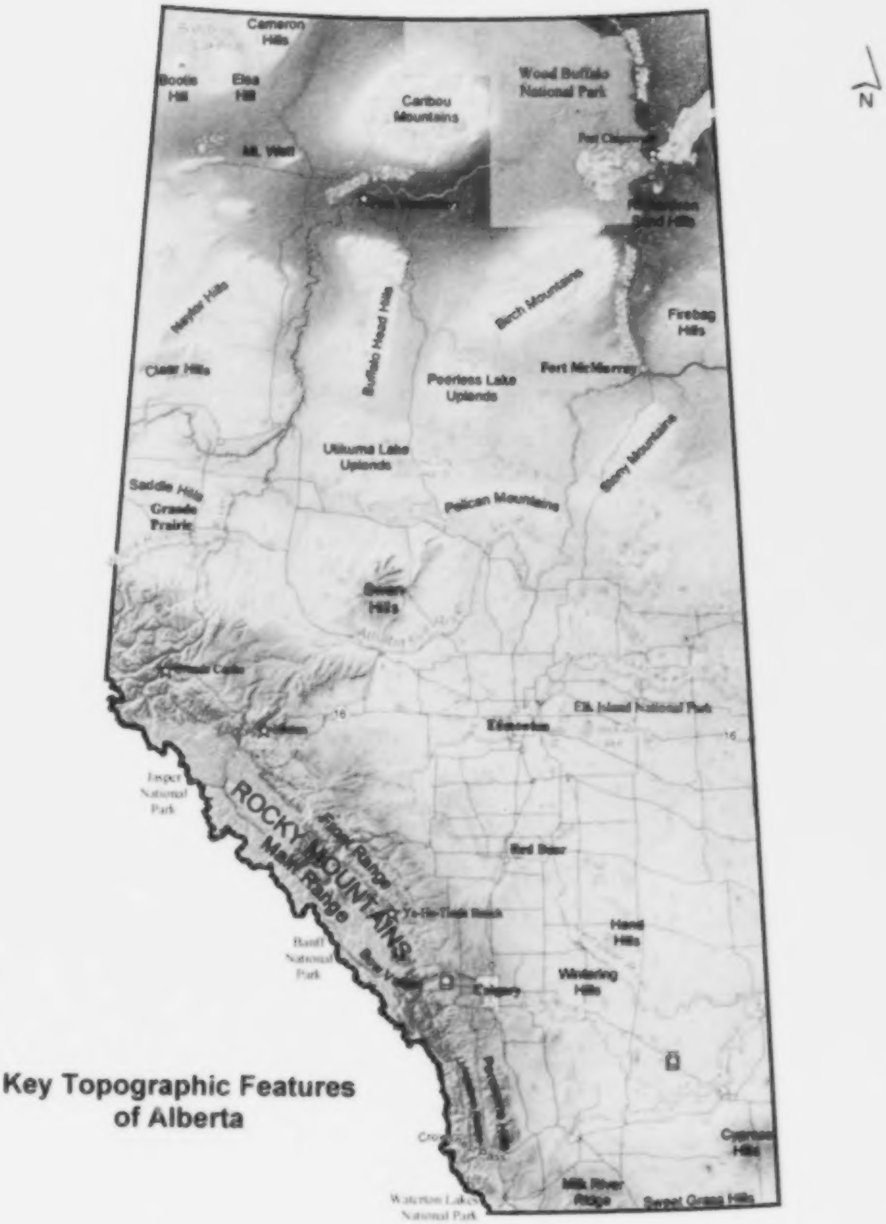

Key Topographic Features of Alberta
N
Cameron Hills
Bootis Hill
Elsa Hill
Caribou Mountains
Wood Buffalo National Park
Fort Chipewyan
Mt. Watt
Richardson Sand Hills
Naylor Hills
Buffalo Head Hills
Birch Mountains
Firebag Hills
Clear Hills
Peerless Lake Uplands
Fort McMurray
Utikuma Lake Uplands
Stony Mountains
Saddle Hills
Grande Prairie
Pelican Mountains
Swan Hills
Grande Cache
Hinton
16
Elk Island National Park
Edmonton
16
Jasper National Park
ROCKY MOUNTAINS
Front Range
Main Range
Red Deer
Ya-Ha-Tinda Ranch
Hand Hills
Banff National Park
Bow Valley
Calgary
Wintering Hills
Porcupine Hills
Crowsnest Pass
Cypress Hills
Milk River Ridge
Sweet Grass Hills
Waterton Lakes National Park

Figure 1-4. Key topographic features of Alberta.

Table 1-4. Summary of changes between 1994 and 2006 Natural Region and Subregion classification.

Natural Region	Natural Subregion	Area 1994 (km²)	Area 2006 (km²)	Degree of change	Details
Rocky Mountain	*Alpine*	14,516	15,084	Minor	Finer-detail mapping at 1:250,000 led to a significant increase in the number of polygons assigned to this Natural Subregion.
	Subalpine	25,766	25,218	Significant	Lower limit of the Subalpine Natural Subregion set at a higher elevation relative to that of the 1994 Subalpine Natural Subregion south of the Canmore corridor. Polygon delineation in southern Alberta better aligned with differentiating criteria.
	Montane	5,985	8,768	Significant	1994 Lower Foothills Natural Subregion polygons south of the Bow River were re-assigned to the Montane Natural Subregion because of similarities to Montane vegetation to the south and the absence of Foothills and Subalpine plant indicator species.
Foothills	*Upper Foothills*	27,550	21,537	Moderate	See discussion of changes for the Lower Foothills and Upper Boreal Highlands Natural Subregions with respect to elevation adjustments and re-assignment of 1994 Upper Foothills Natural Subregion. Upper Foothills boundary refinements used detailed forest cover maps to differentiate pure conifer-dominated landscapes (Upper Foothills) from conifer–mixedwood–deciduous landscapes (Lower Foothills).
	Lower Foothills	67,316	44,899	Significant	No change in criteria for differentiating the Lower and Upper Foothills Natural Subregions; the Lower Foothills–Upper Foothills Natural Subregion boundary generally adjusted to higher elevations based on better digital forest inventory data and understory indicator plant species information. South of the Bow River, the 1994 Lower Foothills Natural Subregion area was re-assigned to the Montane Natural Subregion based on vegetation indicators.
Grassland	*Dry Mixedgrass*	47,004	46,937	Minor	Boundary refinements to reflect more detailed soils information.
	Mixedgrass	19,240	20,072	Minor	Boundary refinements reflect more detailed soils and vegetation information.
	Northern Fescue	15,836	14,933	Minor	Boundary refinements reflect more detailed soils and vegetation information.
	Foothills Fescue	14,908	13,623	Minor	Small areas reassigned to adjacent Natural Subregions to better align with actual vegetation patterns, particularly in southern portion of Natural Subregion.

Table 1-4 (continued).

Natural Region	Natural Subregion	Area 1994 (km²)	Area 2006 (km²)	Degree of change	Details
Parkland	*Foothills Parkland*	4,392	3,921	Minor	Boundary changes to reflect vegetation patterns in forest inventory and satellite imagery.
	Central Parkland	53,404	53,706	Minor	More detailed soil classifications used as differentiating criteria for boundary change.
	Peace River Parkland	4,657	3,120	Moderate	Subregion defined by areas where Chernozemic soils are dominant, as these represent the core Parkland condition. Adjacent south-facing slopes along the Peace and Smoky Rivers are included because of characteristic parkland vegetation structure.
Boreal Forest	*Dry Mixedwood*	100,551	85,321	Moderate	The climate and soils of an area west of Edmonton classified as part of the 1994 Dry Mixedwood Natural Subregion better fits the 2006 Central Mixedwood concept.
	Central Mixedwood	154,549	167,856	Significant	Revised concepts resulted in the partial re-assignment of some adjacent Subregions to this Subregion. It now contains the southern part of the 1994 Wetland Mixedwood Natural Subregion, western portions of the Dry Mixedwood, eastern portions of the Lower Foothills west and south of Edmonton, areas along the northern slope of the Swan Hills, the lower south slopes of the Caribou Mountains and areas east of Fort Vermilion belonging to the 1994 Dry Mixedwood and Peace River Lowlands Natural Subregions. Some areas that belonged to the 1994 Central Mixedwood Natural Subregion are now part of the Athabasca Plains Natural Subregion and the newly added Lower Boreal Highlands Natural Subregion. Two slightly higher-elevation areas east of Edmonton formerly classified as Dry Mixedwood (one between Smoky Lake and Lac la Biche, and one east of Bonnyville) have been assigned to the Central Mixedwood Natural Subregion
	Lower Boreal Highlands	21,217 (total of Boreal Highlands 1994)	55,615	Significant	A newly recognized Natural Subregion, includes diverse mixedwood forests at lower elevations at northerly latitudes. Also includes lower-elevation areas of the 1994 Boreal Highlands Natural Subregion and all the area formerly assigned to the 1994 Lower Foothills Natural Subregion in the Clear Hills.

Table 1-4 (continued).

Natural Region	Natural Subregion	Area 1994 (km²)	Area 2006 (km²)	Degree of change	Details
	Upper Boreal Highlands	21,217 (total of Boreal Highlands 1994)	11,858	Significant	This new Subregion includes upper elevation areas of closed canopy hybrid lodgepole pine–jack pine and spruce forests at northerly latitudes; includes upper portions of the 1994 Boreal Highlands Natural Subregion and parts of the 1994 Boreal Subarctic Natural Subregion. Areas previously assigned to the Upper Foothills Subregion in the Clear Hills have been re-assigned to this Natural Subregion, based on climate models that suggest these areas have a greater affinity to Boreal than to Cordilleran climatic regimes.
	Athabasca Plain	6,750	13,525	Significant	This Subregion was re-assigned from the Canadian Shield Natural Region to the Boreal Forest Natural Region; original boundary was based on bedrock geology and followed the extent of the area underlain by the Athabasca Formation. The new boundary includes a more extensive area of coarse textured sands and gravels that support stands of jack pine. Some areas that formerly belonged to the Central Mixedwood Natural Subregion were reassigned to this Subregion for physiographic reasons.
	Peace–Athabasca Delta (formerly Peace River Lowlands)	10,106	5,535	Significant	The 1994 Peace River Lowlands Natural Subregion included the Peace–Athabasca Delta and fluvial and glaciofluvial terraces of the Birch, Slave and Peace Rivers to the north and west. The newly named Peace–Athabasca Delta Natural Subregion includes only recent fluvial deposits and wetlands.
	Northern Mixedwood (formerly Wetland Mixedwood)	38,345	29,513	Significant	This new Subregion replaces the 1994 Wetland Mixedwood Subregion; the former name was misleading, as it incorrectly implied that this area had a higher concentration of wetlands than other Subregions in the Boreal Forest Natural Region. The southwest portion of the former Wetland Mixedwood Subregion is re-assigned to the Central Mixedwood Subregion based on warmer climates and associated mixedwood vegetation. Part of the Cameron Hills previously classified as the Boreal Subarctic Natural Subregion was re-assigned to the Northern Mixedwood Natural Subregion on the basis of climatic models.
	Boreal Subarctic	21,979	11,823	Moderate	Reduced in size compared to the 1994 Subregion, and now includes only the highest elevations in the Cameron Hills and the top of the Caribou Mountains. Possibly occurs in the Birch Mountains to the east, but too small to be mapped as part of this Natural Subregion.
Canadian Shield	*Kazan Upland*	8,957	9,719	Minor	Minor boundary changes reflect more detailed mapping (1:250,000) in this revision

PART 2. METHODS

2.1 PROCESS

This revised Natural Regions and Subregion classification was developed through a review process that involved representatives from four provincial government departments (Sustainable Resource Development, Alberta Environment, Alberta Agriculture, Food and Rural Development, and Community Development) and the federal government (Agriculture and Agri-Food Canada). Input from others in the public and private sector was solicited and incorporated where possible.

The review process began in 2000 using the 1994 Natural Region and Subregion concepts. Comments and input were reviewed, and vegetation, soils and climate patterns were examined for each Natural Subregion to determine those that were inconsistent with the original concepts, or which were inconsistent with the currently available data. Owing to advances made in spatial modeling, elevation criteria were more closely evaluated than had been possible for the 1994 classification.

The review committee made extensive reference to the newly developed Alberta Climate Model (ACM) (Alberta Environment 2005). GIS technology was used to integrate climate model outputs with numerous other spatial data sources; historic reports and focused field surveys were also used.

The provincial digital elevation model (DEM) was one of several datasets used.

2.2 CLIMATE ANALYSIS

A model designed to predict a suite of climate variables for any geographic point in Alberta, and which was based on raw monthly Environment Canada data normalized to the 1961–1990 period, was used to generate climate statistics. The process used an approach called "thin plate splining" (ANUSPLIN software) to interpolate between climate stations on a 1-km grid across Alberta, and included small areas bordering Alberta in adjacent jurisdictions. Details of the process are provided in the ACM report (Alberta Environment 2005). Climate normals and latitude, longitude and elevation data were used in the modelling process.

A total of 64 variables were evaluated for all Natural Regions and Subregions. Forty-eight of these are termed primary variables and include the following:

- monthly mean daily temperature (12 variables);
- monthly mean daily maximum temperature (12 variables);
- monthly mean daily minimum temperature (12 variables); and
- monthly mean precipitation (12 variables).

Seventeen other "derived" variables were calculated from the primary climate data, and were chosen for their potential to provide insights into ecological responses to climate. These variables are:

- mean annual temperature;
- mean temperature of the warmest month;
- mean temperature of the coldest month;
- mean maximum daily temperature of the warmest month;
- mean minimum daily temperature of the coldest month;
- degree-days above 5°C annually;
- degree-days above 5°C during the April–August growing season;

- degree-days less than 0°C;
- date on which degree-day above 5°C sum reaches 100;
- summer–winter temperature differential, or "continentality", determined by subtracting the mean temperature of the coldest month from the mean temperature of the warmest month;
- mean frost-free period;
- mean date of last spring frost;
- mean date of first fall frost;
- mean annual precipitation;
- mean growing season precipitation (April through August);
- annual moisture index (degree-days >5°C divided by mean annual precipitation); and
- summer moisture index (degree-days >5°C divided by mean growing season precipitation).

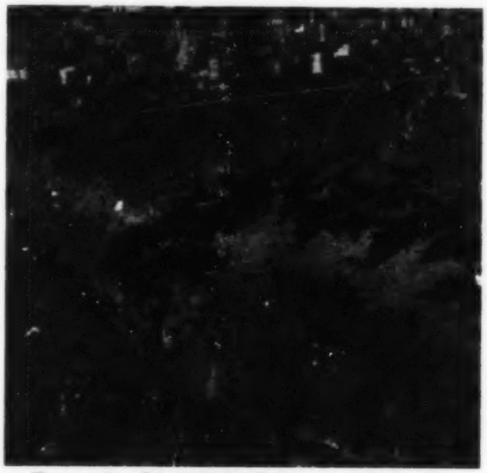
In addition to mean values, other descriptive statistics included minimum and maximum interpolated values, the range of values, and the standard deviation of the mean.

Climate variable values were displayed using GIS. The resulting shaded maps were used to gain insights into temperature and precipitation trends and their relationship to biophysical features that were directly used in mapping. Figures 2-1 through 2-4 show some of the more revealing provincial patterns in mean annual temperature, mean annual precipitation, growing degree days and "continentality" displayed on a topographic backdrop together with Natural Subregion line work. Figure 2-5 shows the areas influenced by Chinook winds in Alberta.

2.3 NATURAL REGION AND SUBREGION REVISIONS

The review committee produced numerous GIS-based spatial overlays to generate a number of landscape perspectives that were not possible in 1994. The primary information sources used for this purpose included:

- 1994 Natural Regions and Subregions map (Alberta Environmental Protection 1994);
- Soil Landscapes of Canada polygons (federal-provincial);
- Physiographic Subdivisions of Alberta (Pettapiece 1986).
- Digital Elevation Model (provincial);
- Alberta Vegetation Inventory and Phase 3 Forest Inventory (provincial);
- LANDSAT and IRS imagery (proprietary);
- Ecological plot data from the provincial plot database (Ecological Site Information System);
- Numerous ecological classification reports and maps (provincial); and
- Wetland inventory (provincial).



Example of LANDSAT imagery from the Cypress Hills area.

Approximately 30 correlation meetings were held over a 4-year period. Initial line work was based on available published data. Inconsistencies, anomalies and conflicts were identified, reviewed and resolved based on personal knowledge or additional limited field surveys of specific areas. Decisions on boundary placement were extended from areas with good data control using elevation contours as a guide. A workshop in October 2004 solicited further input from government, industry, academic institutions and the general public, and revisions were finalized in January 2005.

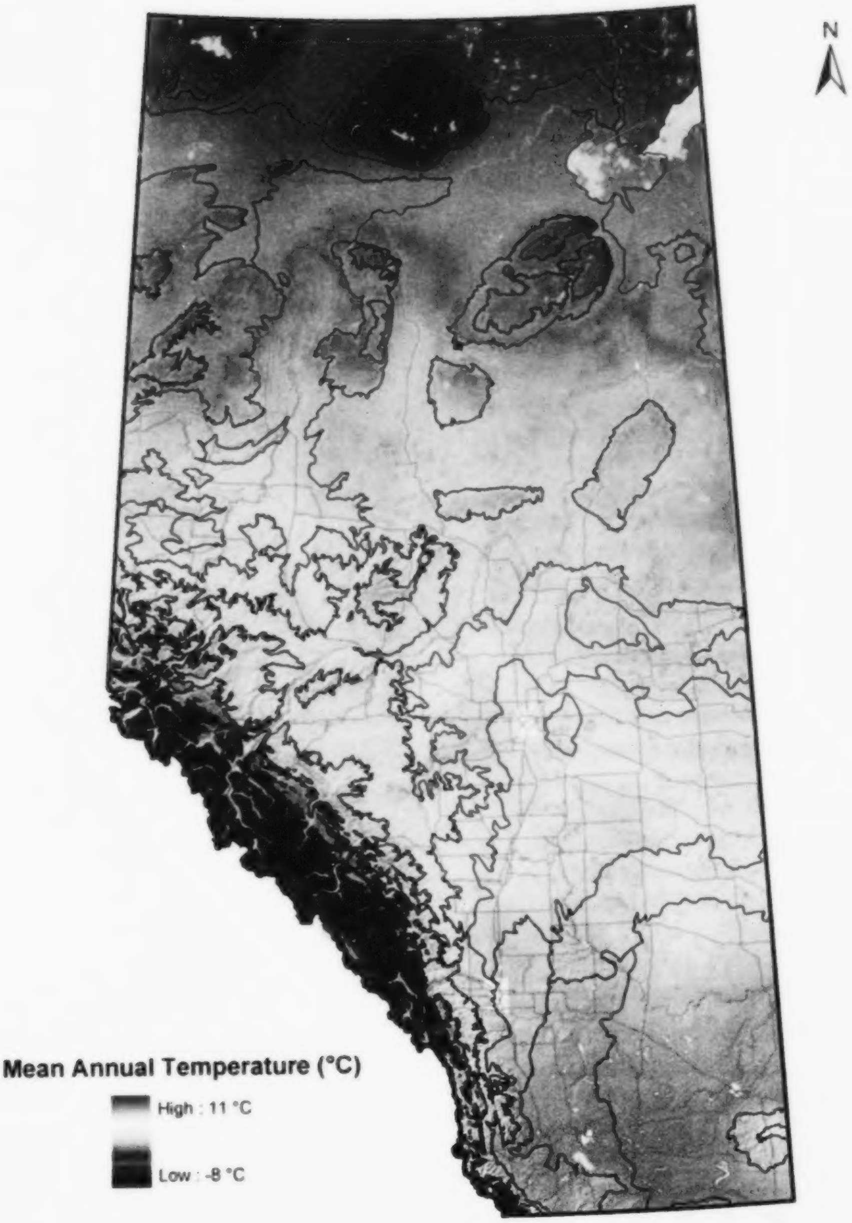

N
Mean Annual Temperature (°C)
High : 11 °C
Low : -8 °C

Figure 2-1. Mean annual precipitation across Alberta. (*Black lines are Natural Subregion boundaries.*)

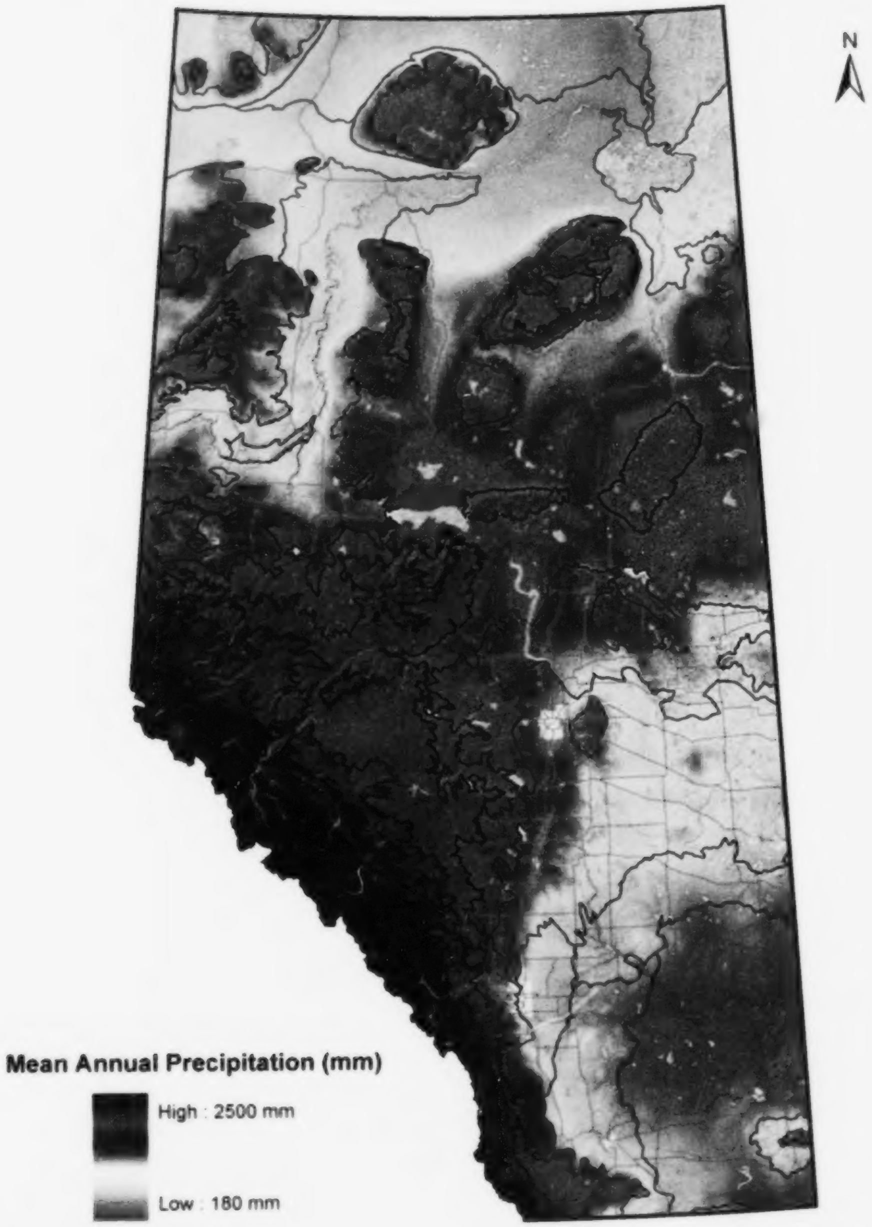

N
Mean Annual Precipitation (mm)
High : 2500 mm
Low : 180 mm

Figure 2-2. Mean annual precipitation across Alberta. (*Black lines are Natural Subregion boundaries.*)

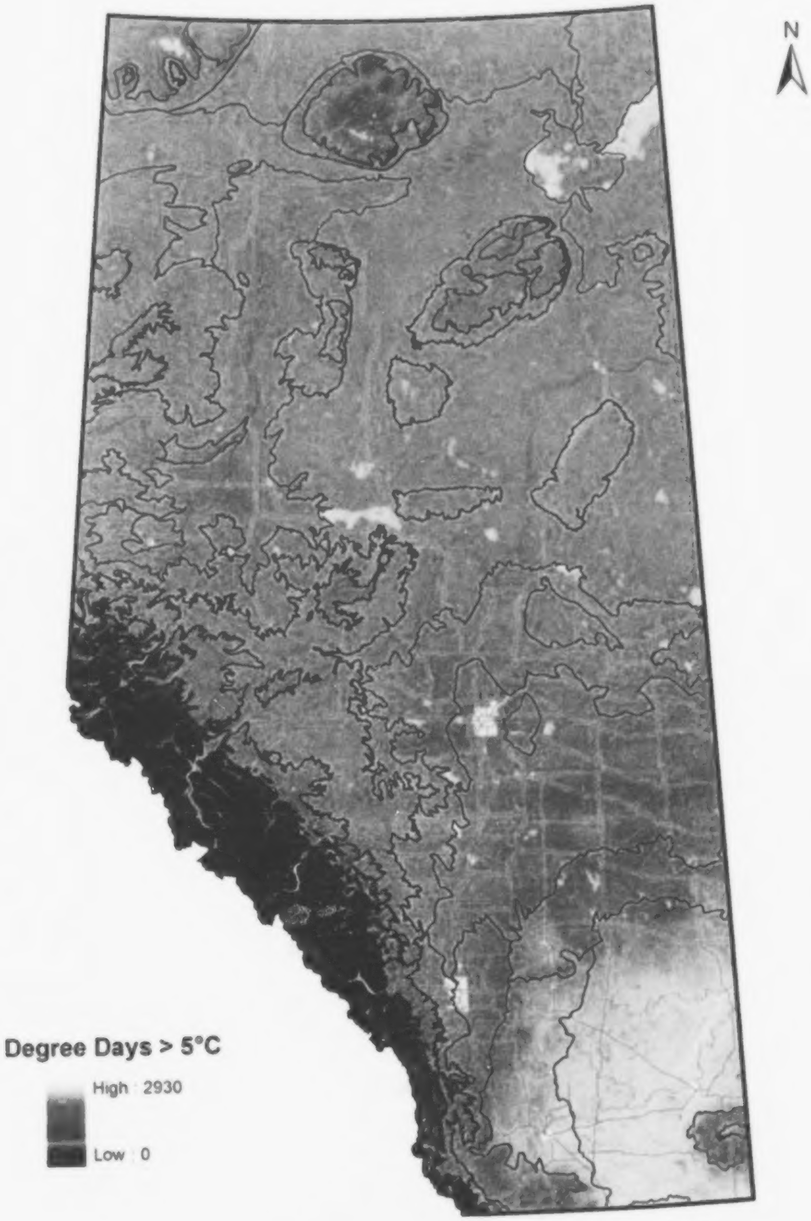

N
Degree Days > 5°C
High : 2930
Low : 0

Figure 2-3. Growing degree days over 5°C across Alberta. (*Black lines are Natural Subregion boundaries.*)

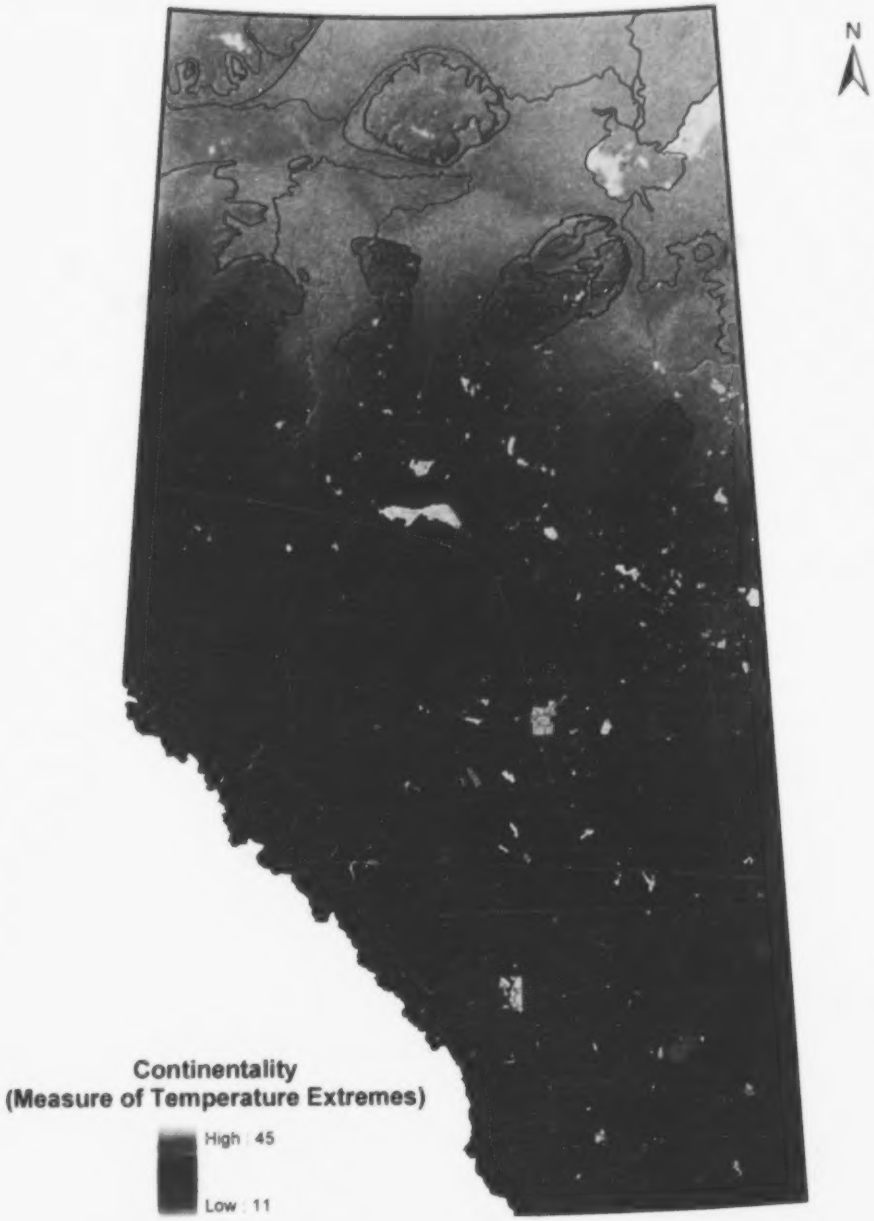
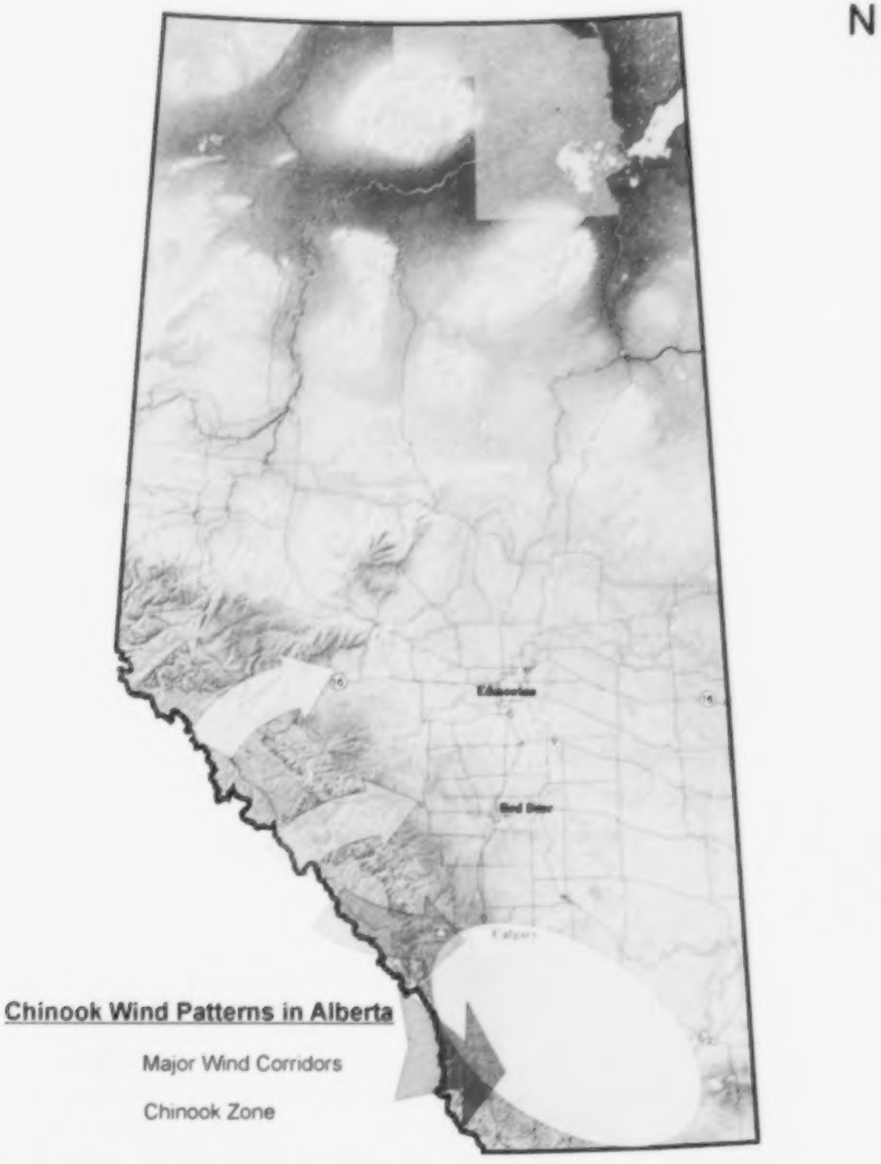

N
Continentality
(Measure of Temperature Extremes)
High : 45
Low : 11

Figure 2-4. "Continentality" index across Alberta. *(Black lines are Natural Subregion boundaries.)*


N
Edmonton
Red Deer
Calgary
Chinook Wind Patterns in Alberta
Major Wind Corridors
Chinook Zone

Note: Temperature effects decrease with increasing latitude

Figure 2-5. Major Chinook wind patterns in Alberta.

PART 3. ALBERTA'S NATURAL REGIONS AND SUBREGIONS — A CLIMATIC AND BIOPHYSICAL OVERVIEW

Part 1 contained discussions on the three major climatic regimes (ecoclimatic provinces) that influence provincial ecosystems. Their relationship to Natural Regions and Subregions was also addressed briefly.

In Part 3, several climatic attributes that help to characterize Natural Regions and Subregions are defined, tabulated and discussed. As well, the major differences between Natural Regions and Subregions are discussed for each attribute. In addition, the main distinguishing biophysical characteristics of all Natural Regions and Subregions are tabulated to facilitate comparisons.

3.1 HOW NATURAL REGIONS ARE CLIMATICALLY RELATED

Three climatic parameters appear to be most useful in explaining the differences between the six Natural Regions. These are given below.

1. **Mean annual temperature** — The average temperature over the course of an entire year, partly indicative of relative energy available for plant metabolism.
2. **Mean annual precipitation** — The average precipitation over the course of an entire year, partly indicative of relative moisture availability for plant growth.
3. **Growing degree-days greater than 5°C (GDD5)** — A measure of energy available for plant growth, defined later in Part 3.

Figure 3-1 shows how these three parameters help define the climatic relationships between Natural Regions and provincial climate regimes. The colored ellipses approximately define the range of conditions typical of the Grassland, Cordilleran and Boreal Ecoclimatic Provinces.

The Boreal Ecoclimatic Province includes the Boreal Forest, Canadian Shield and Foothills Natural Regions. The Foothills Natural Region represents a transition between the Cordilleran and Boreal Ecoclimatic Provinces. The average annual temperature and precipitation are influenced by both climatic regimes. The Foothills Natural Region tends to be wetter and somewhat cooler than the Boreal Natural Region, but drier and somewhat warmer than the Rocky Mountain Natural Region. Within the Foothills Natural Region, the higher elevation Upper Foothills Natural Subregion is more strongly influenced by Cordilleran climates than is the Lower Foothills Natural Subregion.

The Grassland Ecoclimatic Province includes the Parkland and Grassland Natural Regions. The Parkland Natural Region represents a transition between the Boreal and Grassland Ecoclimatic Provinces, with lower precipitation than the Boreal Natural Region, higher precipitation than the Grassland Natural Region, and temperature and GDD5 values intermediate between the two.

Within the Parkland Natural Region, the Peace River Parkland Natural Subregion shows the strongest affinity to the Boreal Ecoclimatic Province. It occurs at higher latitudes where solar energy inputs are lower and where continental polar and arctic air masses are more influential than in the other two parkland Natural Subregions. The Foothills Parkland Natural Subregion lies along the Front Ranges of the Rocky Mountains and is influenced somewhat by Cordilleran climates.

The Cordilleran Ecoclimatic Province includes the Rocky Mountain Natural Region. Mean annual temperatures and growing degree days are significantly lower than other Regions, and mean annual precipitation (except for the Montane Natural Subregion) is significantly higher, reflecting the effect of increased elevation.

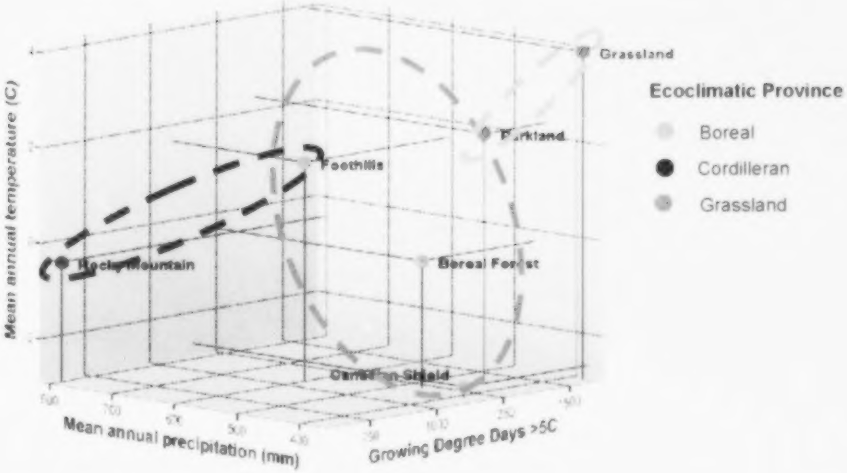


Figure 3-1. General climatic relationship between Natural Regions and Ecoclimatic Provinces.

3.2 CLIMATIC ATTRIBUTES OF NATURAL REGIONS AND SUBREGIONS

This section provides a summary of modeled annual temperature and precipitation-related climate variables, and concludes with a brief discussion of their relationship to very broad provincial vegetation patterns. Mean monthly temperature and precipitation statistics are presented in Part 4 (Natural Region descriptions). Detailed climate statistics, including mean, minimum, maximum, range and standard deviation, are provided in Appendix 2.

3.2.1 Temperature-Related Statistics

Several annual temperature statistics that characterize Natural Regions and Subregions (Tables 3-1 and 3-2, respectively) are presented at the end of this Part and are discussed below. Figure 3-8 presents an overview of monthly temperatures for all Natural Subregions (these charts are presented in larger format in Part 4).

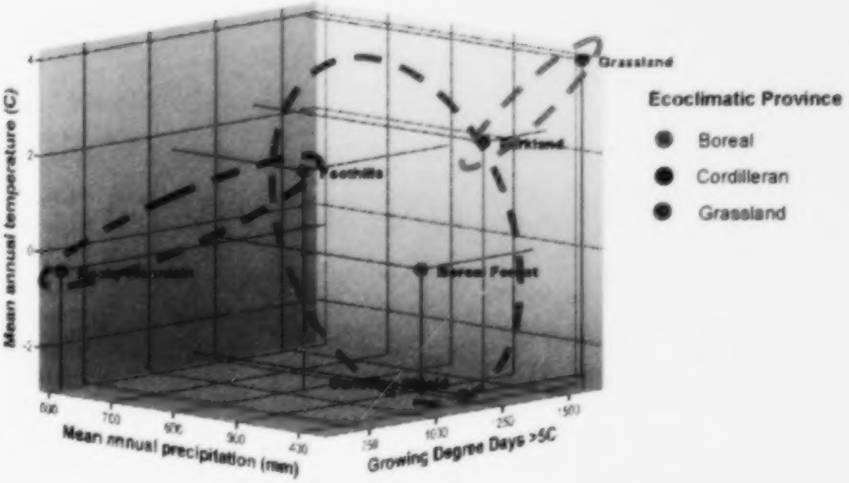
Monthly color patterns in Figure 3-8 illustrate Natural Subregion trends by latitude and elevation. Figure 2-1 (in Part 2) shows mean annual temperature variations between and within Natural Subregions across Alberta.

3.2.1.1 Mean Annual Temperature and Monthly Variations

Mean annual temperature (MAT) decreases with both elevation and latitude (Figure 3-2). The Alpine Natural Subregion at the highest elevations, and the Boreal Subarctic, Kazan Uplands and Northern Mixedwood Natural Subregions at the most northerly latitudes, have the lowest MAT values. In contrast, the southerly Grasslands Natural Region receives higher insolation and the Mixedgrass and Dry Mixedgrass Natural Subregions have the highest MAT values.

3.2.1.2 Mean Temperature of Warmest and Coldest Months

Mean temperatures of the warmest and coldest months by Natural Subregion are shown in Figure 3-3. Mean temperature of the warmest month (MTWM) is either July or August. Temperatures are coolest at high elevations (the Alpine and Subalpine Natural Subregions), and warmest in the Grassland Natural Region. Summers can be quite warm even at northerly latitudes; however, growing degree day totals and monthly temperature charts (refer to individual Natural Subregion descriptions in



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Part 4) indicate that warm periods are brief in the Canadian Shield, Boreal Forest, Foothills and Rocky Mountain Natural Regions, and longer in the Grassland and Parkland Natural Regions.

Mean temperature of the coldest month (MTCM), which is either December or January, varies widely between Natural Regions and Subregions. It decreases with increasing latitude and reflects both the shorter days and the influence of cold, dry continental polar and Arctic air masses for extended periods in the Boreal Forest and Canadian Shield Natural Regions.

Pacific air masses and Chinook events influence southern Alberta climates. Those Natural Subregions adjacent to and within the lower valleys of the Front Ranges (the Foothills Fescue, Foothills Parkland and Montane) enjoy the warmest average winter temperatures in the province.

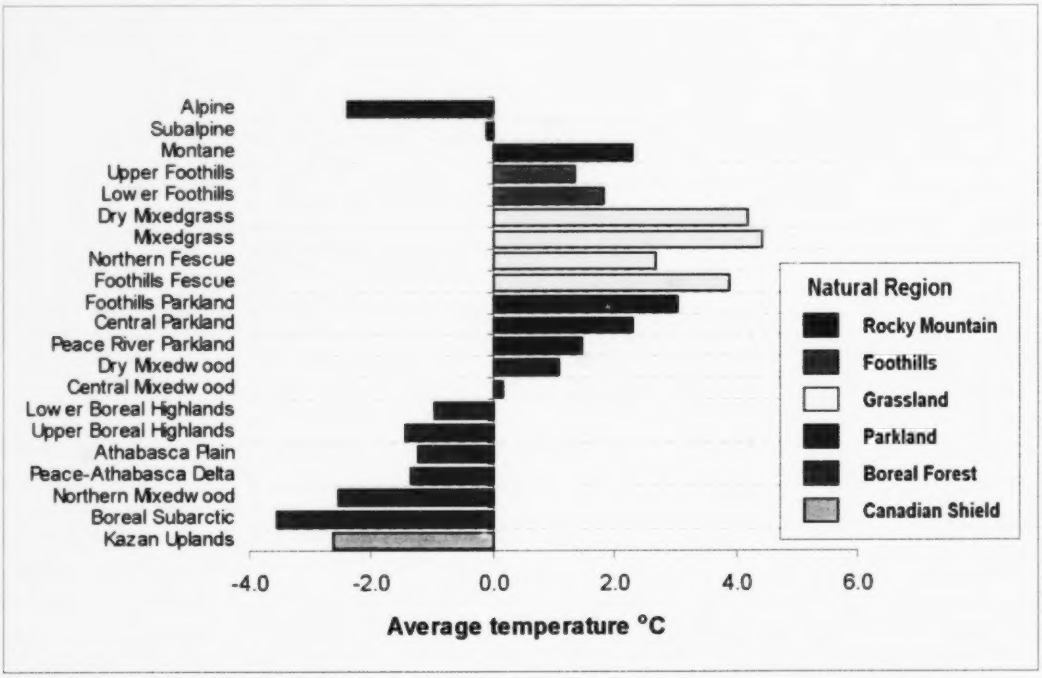

Figure 3-2. Mean annual temperature of Natural Subregions, grouped by Natural Region.

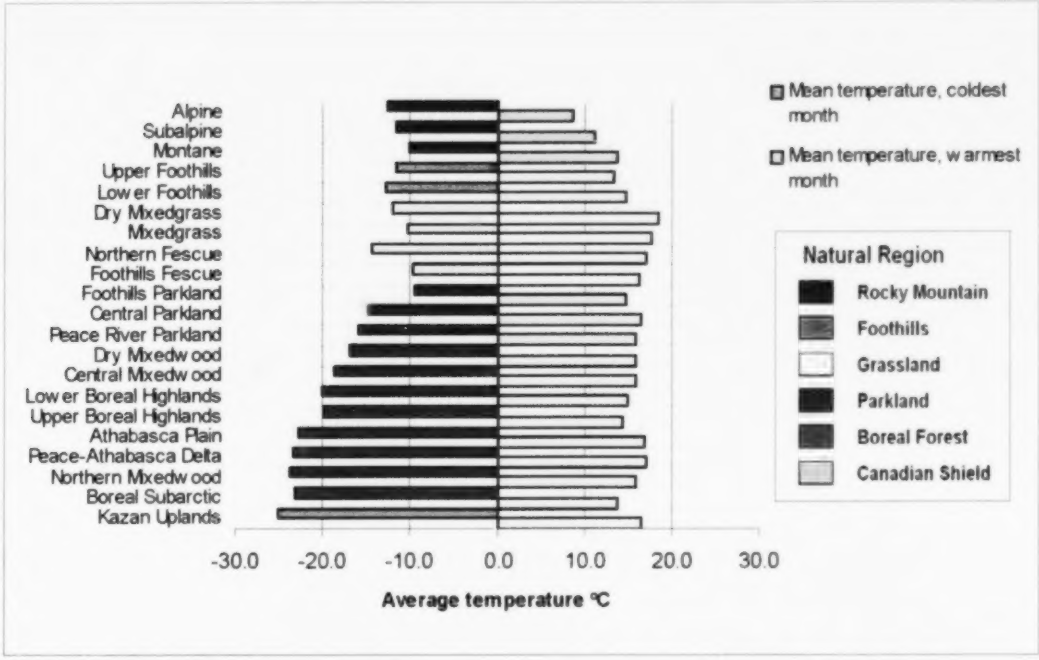

Figure 3-3. Mean temperatures of the coldest and warmest months, grouped by Natural Region.

3.2.1.3 Mean Daily Maximum and Minimum Values

Mean daily maximum values are the average daily maxima for June, July and August; mean daily minimum values are the average daily minima for December, January and February. Figure 3-4 shows the same latitudinal and elevational trends for Natural Subregions as those for MTCM and MTWM discussed in the previous section.

The effect of elevation on mean daily maxima are more noticeable; the Alpine, Subalpine, Upper Foothills, Upper Boreal Highlands and Boreal Subarctic Natural Subregions all have mean daily maxima less than 20°C, and all are at higher elevations than the surrounding terrain. Mean daily maximum values vary the most in the Alpine and Subalpine Natural Subregions, with a range of 18° and 15° in July compared with a 2° to 8° range for other Natural Subregions (Appendix 2).

These two Natural Subregions occur across a broad range of elevations (about 600 m for the Subalpine and up to 1000 m for the Alpine compared to 300 m or less for other Natural Subregions. The corresponding temperature ranges are higher, with highly variable slopes and aspects also contributing (e.g., solar energy is lower on steep northerly slopes than on steep southerly slopes).

3.2.1.4 Growing Degree-Days

Growing degree-days (GDD) are used to match plant requirements for heat to the amount of heat available, and permit comparisons of areas in terms of plant growth potential. The reference temperature for calculating GDD is the minimum threshold temperature at which plant growth starts. For most plants, this is considered to be 5°C. Growing degree-days are calculated by taking the average daily temperature and subtracting the reference temperature. For example, a day with an average temperature of 21°C accumulates 16 GDD using a reference temperature of 5°C[2]. This measure is abbreviated as GDD5, and is the most commonly reported GDD statistic.

Two other measures of GDD that use different reference temperatures include "negative" degree-days where degree-days below 0°C (DD<0) are accumulated, and growing degree days greater than 0°C (GDD>0). The date on which accumulated GDD5 degrees equal 100 (GDD100) is considered potentially important to plant development (Alberta Environment 2005).

The Rocky Mountain Natural Region has the lowest GDD5 values. (Photo: K. Crockett)

GDD5 and DD<0 are shown in Figure 3-5. Because they are calculated from basic temperature statistics, they reflect geographic trends in seasonal conditions similar to the previously reported temperature values. Overall, the Rocky Mountain Natural Region has the lowest GDD5 values, followed by the Foothills, Canadian Shield, Boreal Forest and Parkland Natural Regions. The Grassland Natural Region has the highest average GDD5 values.

There is considerable variation within some Natural Regions; for example, in the Boreal Forest Natural Region, average GDD5 ranges from a low of about 870 in the higher elevation, high-latitude Boreal Subarctic Natural Subregion to a high of about 1300 in the lower elevation and lower latitude Dry Mixedwood Natural Subregion. Figure 2-3 (in Part 2) shows the distribution of GDD5 conditions across Alberta.

The differences in winter severity between Natural Regions and Subregions is readily apparent from the DD<0 summary on the left side of Figure 3-5. The Canadian Shield and Boreal Forest Natural Regions are more strongly influenced by continental polar and continental arctic[3] air masses than other Regions, producing a larger accumulation of negative degree-days in northerly latitudes.

GDD100 dates are widely variable between and sometimes within Natural Regions. They are closely related to GDD5 trends, from which they are derived, and less closely related to frost-free period. The earliest dates at which 100 GDD5 days are accumulated are in early to mid-May on average in the Grassland and Parkland Natural Regions. By the third week of May, the Boreal Forest Natural Region has usually accumulated 100 degree-days, except for the higher elevation Upper Boreal Highlands and Boreal Subarctic Natural Subregions.

Croplands are the most common in the Grassland and Parkland Natural Regions, in part due to their more favorable GDD5 values. (Photo: L. Allen)

Decreasing temperatures at higher elevations produce a significant lag in GDD100 dates for the Rocky Mountain Natural Region. It is not until late June or early July on average that 100 growing degree-days are accumulated in the Alpine and Subalpine Natural Subregions.

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[2] *Source: Alberta Agriculture, www 1.agric.gov.ab.ca/$department/deptdocs.nsf/all/sag6301*

[3] *Refer to Part 1 (Climates) for more detail*

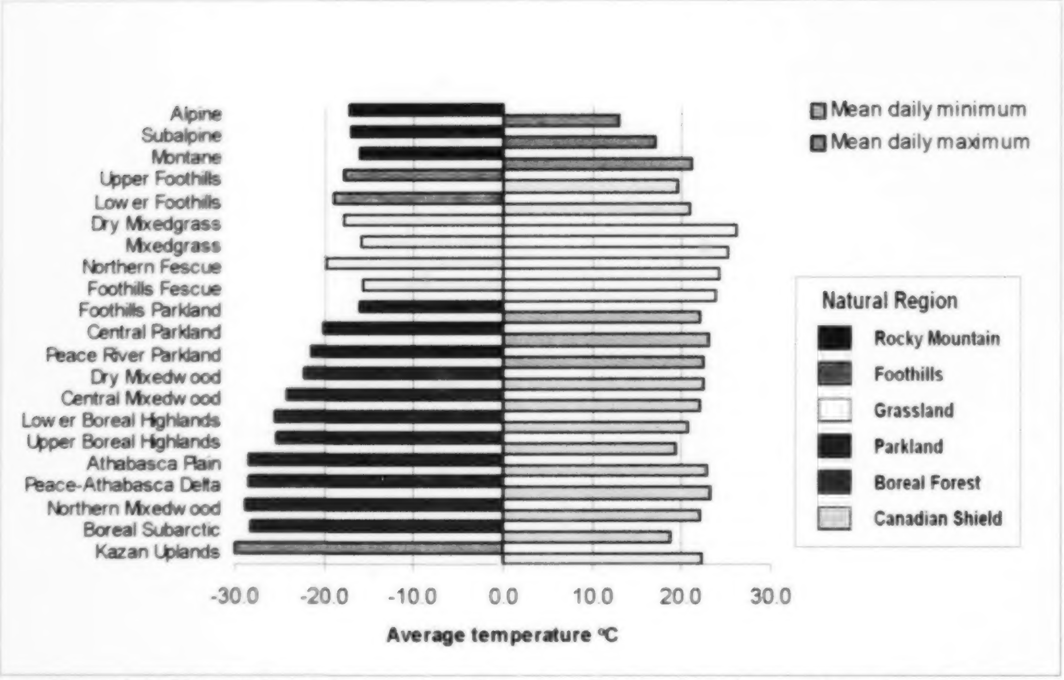

Figure 3-4. Mean daily minimum values (Dec., Jan., Feb.) and maximum values (Jun., Jul., Aug.).

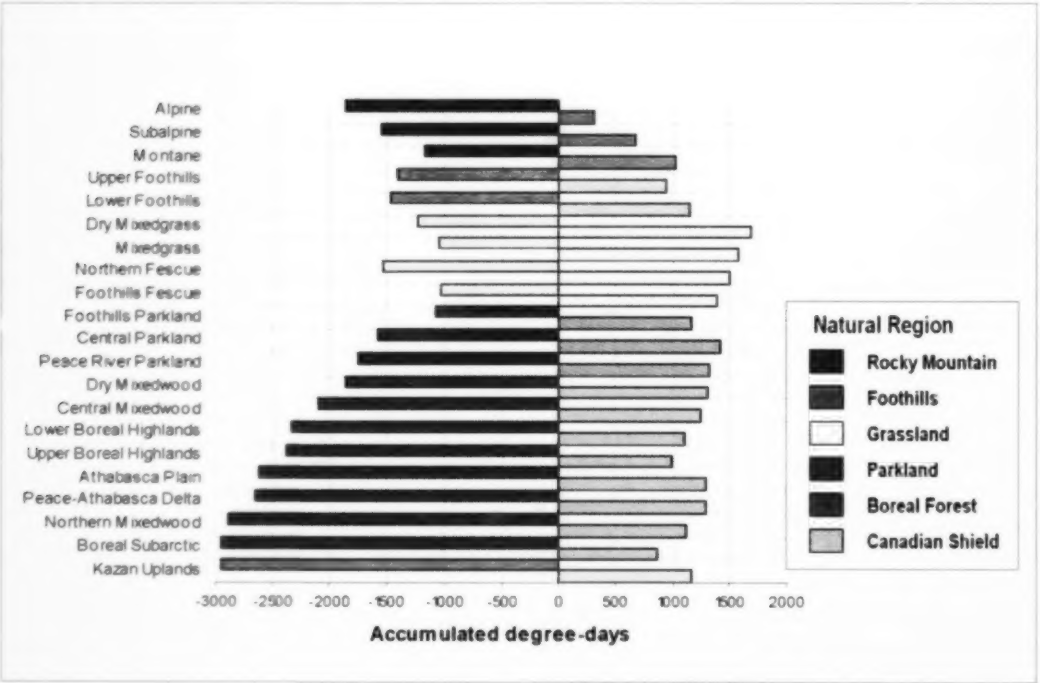

Figure 3-5. DD<0°C (solid bar) and GDD>5°C (striped bar).

3.2.1.5 Frost-Free Period

Frost-free period is another indicator of temperature regimes that are favourable or unfavourable to plant growth. This variable is often used for assessing crop growth suitability, but also gives some indication of the growth period available to native species.

Frost-free trends are not as closely linked to latitude as mean annual temperature. The Peace–Athabasca Delta and Athabasca Plain Natural Subregions in the far north have almost as long a frost-free period as more southerly areas such as the Northern Fescue and Central Parkland Natural Subregions. Figure 3-6 shows the predicted frost-free period (striped bars) and the range between the maximum and minimum predicted period (solid bars).

The factor that appears to contribute most to short, erratic, frost-free periods is terrain variability and elevation; generally, the higher the elevation and the rougher the terrain, the shorter and more unpredictable the period. This is probably due to aspect variations (north vs. south slopes) and cold air drainage from higher to lower terrain. The latter can produce "reverse" tree lines in valley bottom locales within the Upper Foothills and Subalpine Natural Subregions where cold air pools at night and retards tree growth.

The Rocky Mountain and Foothills Natural Regions, and the Foothills Parkland, Foothills Fescue and Dry Mixedwood Natural Subregions, all exhibit relatively high frost-free period variability. With the exception of the Dry Mixedwood Natural Subregion, all occur at average elevations over 1000 m and with average slopes of greater than 2°.

The Dry Mixedwood Natural Subregion is variable, probably because it extends from just north of the Bow River Corridor in the south to just south of the Caribou Mountains in the north. This is a south-to-north distance of nearly 800 km, and includes a number of weather stations in variable topographic locations.

Frost-free period and average dates of last spring frost and first fall frost reported in Table 3-2 are highly unreliable because of both year-to-year variations in weather patterns and topographic variability, especially in the Natural Regions and Subregions mentioned above. For more precise information, readers should consult climate station data in the locale of interest.

3.2.1.6 Continentality

"Continentality" is a relative index of the degree to which an area is affected by continental rather than Cordilleran influences. It is calculated simply by subtracting the mean temperature of the coldest month from the mean temperature of the warmest month.

The area with the highest continentality (Figure 3-6) is the Kazan Uplands Natural Subregion in extreme northeastern Alberta. Here the long, cold winters resulting from short days and Arctic frontal influences during the winter months alternate with short, warm summers. This is a typical continental regime.

At the other extreme is the Alpine Natural Subregion, which is entirely within the Cordillera. In this Subregion, the cold conditions prevail throughout the year and the temperature range is correspondingly lower.

Figure 2-4 (in Part 2) indicates continentality trends across Alberta. This figure shows that several Natural Subregions are influenced by their proximity to the mountains. The Lower and Upper Foothills, Foothills Parkland, Foothills Fescue, Montane, Alpine and Subalpine Natural Subregions are all within or close to the Rocky Mountain Front Ranges and have relatively low continentality values. The comparatively higher continentality of the Lower and Upper Boreal Highlands Natural Subregions compared to the Lower and Upper Foothills Natural Subregions supports re-assigning the 1994 northerly Foothills outliers to the Lower and Upper Boreal Highlands.

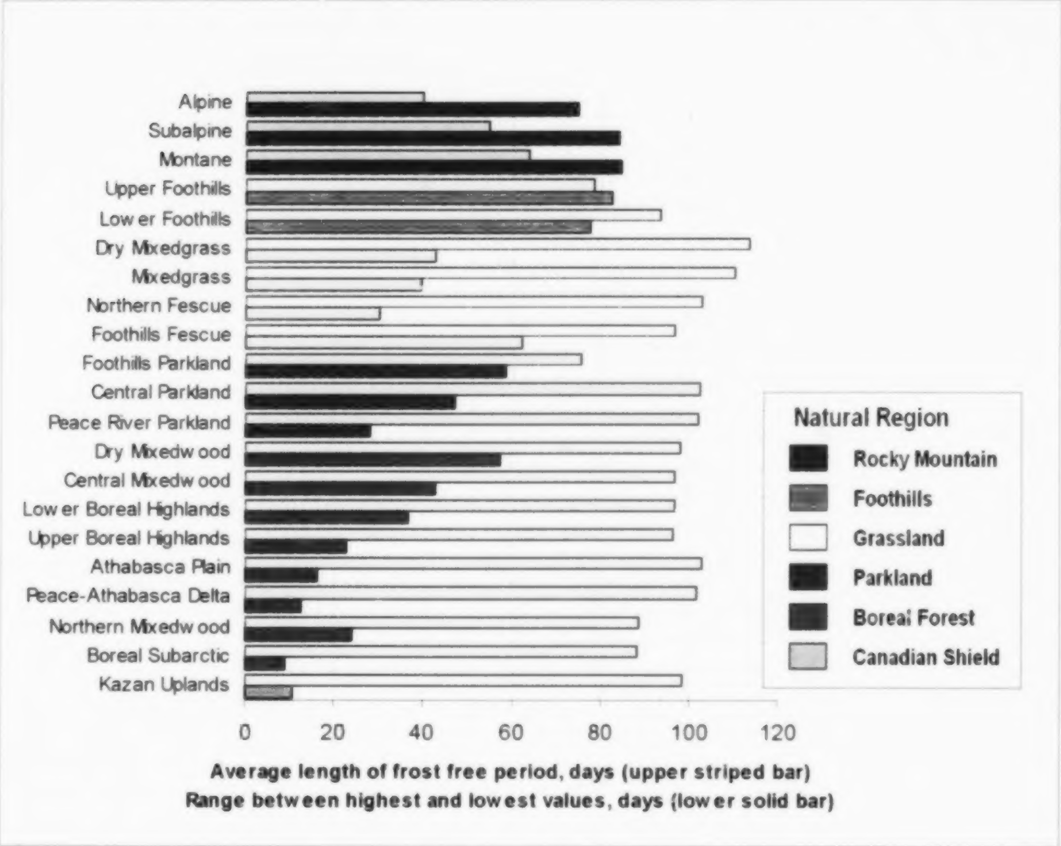

Figure 3-6. Frost-free period, mean length (days) and range (days).

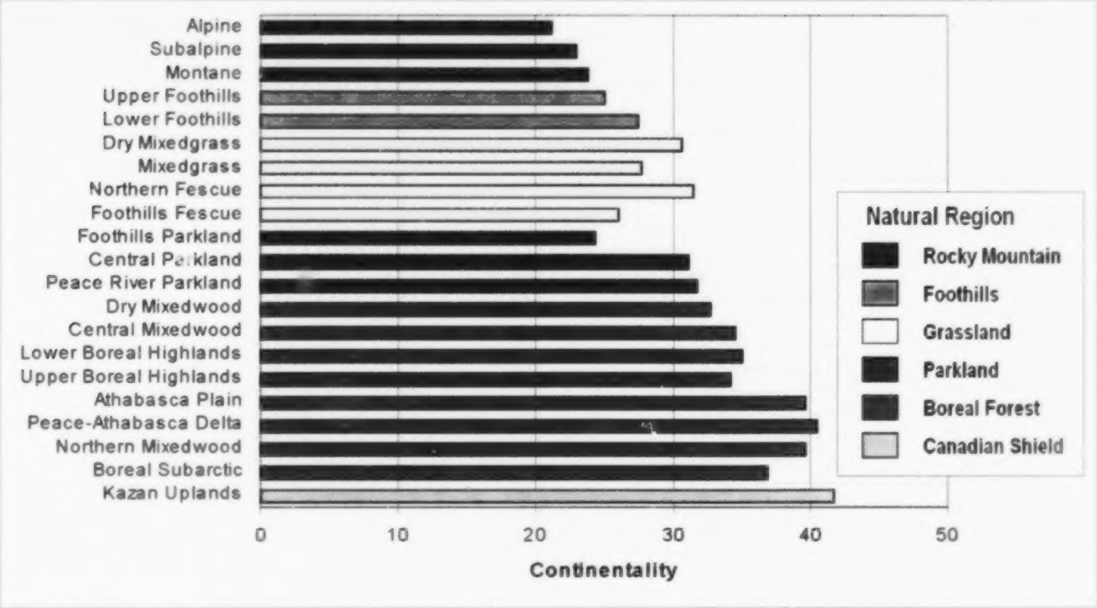

Figure 3-7. Relative continentality of Natural Subregions.

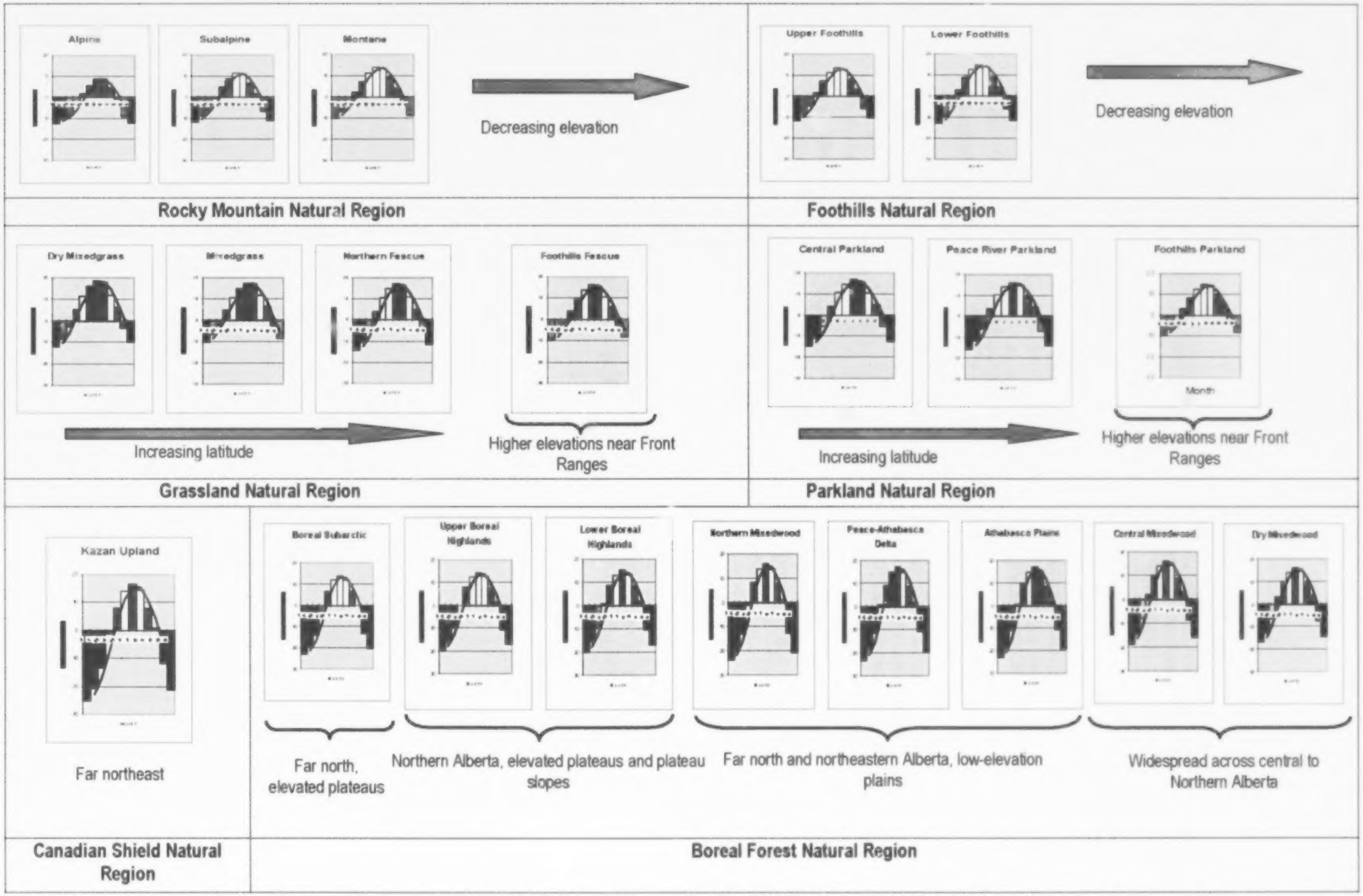

Figure 3-8. Comparison of mean monthly temperature trends for all Natural Subregions. (*Red= >15°C, Yellow = 10 to 15°C, Green = 0 to 10°C, Light Blue = -10 to 0°C, Dark Blue = -20 to -10°C, Purple = -30 to -20°C. Time axis is January to December. Refer to Part 4 for more detailed bar charts.*)

3.2.2 Precipitation-Related Statistics

The amount of water available for plant growth is also an important and distinguishing climate variable. Several statistics that summarize the annual precipitation characteristics of Natural Regions and Subregions are summarized in Tables 3-1 and 3-2, respectively, and are discussed below.

3.2.2.1 Mean Annual Precipitation

Four trends are immediately apparent from an examination of mean annual precipitation (MAP) values (Figure 3-9) and Figure 2-2 (in Part 2):

1. The Rocky Mountain and Foothills Natural Regions receive substantially more annual precipitation than other Regions. This trend is indicative of Cordilleran climatic influences.
2. The other four Natural Regions receive similar MAP. The northernmost low-elevation Natural Subregions (e.g., the Peace–Athabasca Delta, Northern Mixedwood and Kazan Uplands) receive about the same amount as the Mixedgrass and Northern Fescue Natural Subregions in central and southern Alberta. These areas have distinctly different vegetation patterns, however, and MAP is clearly not the only factor that determines these patterns.
3. Precipitation amounts within Natural Regions increase somewhat with elevation. The Alpine, Upper Foothills, Foothills Fescue, Foothills Parkland, Upper Boreal Highlands and Boreal Subarctic Natural Subregions all have higher MAP values than other Subregions within the same Region. Each is at the highest elevation in its respective Natural Region.
4. Precipitation is highly variable in those Natural Regions that occur within or along the Rocky Mountains, where topographic effects produced by valley orientation (north-south vs. east-west), slope orientation and elevation result in very different precipitation regimes. The Rocky Mountain and Foothills Natural Regions both exhibit high MAP variability, with a significant drop in variability in the lower elevation Lower Foothills Natural Subregion. The Foothills Fescue and Foothills Parkland Natural Subregions are also highly variable and are probably influenced by the adjacent Front Ranges. The Central Mixedwood Natural Subregion may be more variable than other Subregions in the Boreal Forest Natural Region because it spans much of the northern two thirds of Alberta.

The following trends are not apparent from Figure 3-9, but clearly stand out in monthly precipitation summaries. Figure 3-11 presents an overview of monthly precipitation for all Natural Subregions (these charts are presented in larger format in Part 4). The monthly color patterns in Figure 3-11 illustrate Natural Subregion trends by latitude and elevation.

- The Alpine and Subalpine Natural Subregions do not have a marked precipitation peak at any time of the year. The Alpine Natural Subregion has two precipitation maxima—one in June and July and the other in November through March. The Subalpine Natural Subregion has a precipitation maximum in June or July. Both Subregions receive substantially more winter precipitation than any other Subregion. All other Natural Subregions display a distinctly peaked, summer-high precipitation pattern.
- The month during which precipitation peaks varies by Natural Region. June is typically the peak month for the Grassland and Parkland Natural Regions. The Foothills, Canadian Shield and Boreal Forest Natural Regions peak in July.
- February is typically the driest month, except in the Alpine Natural Subregion where it is wetter than average.
- The Upper Foothills and Lower Foothills Natural Subregions have the highest average single month rainfalls which occur in July.
- The Upper Foothills, Lower Foothills, Upper Boreal Highlands, Lower Boreal Highlands, Central Mixedwood and Dry Mixedwood Natural Subregions have very

similar precipitation patterns for April through August, receiving between 65 and 75 percent of MAP during the growing season.

3.2.2.2 Growing Season Precipitation

Growing season precipitation (GSP) is the portion of MAP that falls from April through August. The ratio "GSP/MAP" reported in Table 3-2 provides another indication of "continentality". Precipitation patterns that peak in summer are indicative of continental climatic influences.

Most GSP/MAP values in Table 3-3 are in excess of 65 percent, meaning that over two-thirds of the total annual precipitation is received in summer. The Alpine and Subalpine Natural Subregions have values of less than 60 percent, indicating a more even distribution of precipitation throughout the growing season.

3.2.2.3 Summer Moisture Index

Summer Moisture Index (SMI), presented in Figure 3-10 is a measure of precipitation effectiveness during the growing season. It is calculated by dividing GDD5 by the growing season precipitation (April through August). A high ratio indicates a greater likelihood that evaporation will exceed precipitation at some time during the growing season[4].

Natural Subregions may be arbitrarily assigned to one of three groups:

1. SMI values greater than four, indicating dry to very dry climatic conditions, with the likelihood of significant moisture deficits for extended periods during the growing season (Grassland Natural Region, Canadian Shield Natural Region, and Peace-Athabasca Delta Natural Subregion).
2. SMI values of three to four, indicating neither dry nor wet climatic conditions, with the likelihood of moderate moisture deficits for short periods during the growing season (all of the Boreal Forest Natural Region except the Boreal Subarctic, Upper Boreal Highlands, and the Central and Peace River Parkland Natural Subregions).
3. SMI values less than three, indicating moist to wet climate conditions, with no moisture deficits during the growing season (Foothills Parkland, Upper Boreal Highlands, and Boreal Subarctic Natural Subregions, and Rocky Mountain and Foothills Natural Regions).

3.2.3 Climate–Vegetation Relationships

Table 3-3 summarizes the range of modeled variable values that appear to be related to the distribution of major forested and non-forested vegetation types. Mean annual temperature, mean annual precipitation and growing degree-days are most closely related to vegetation patterns. In summary:

- Black spruce-dominated[5] forests and the common occurrence of permafrost are associated with mean annual temperature values less than -2.5°C.
- Conifer-dominated forests (lodgepole pine, lodgepole pine x jack pine hybrids, white spruce and Engelmann spruce) are associated with mean annual temperature values between -2.0 and +1.0°C, mean annual precipitation amounts greater than 500 mm, and growing degree-day values between 400 and 1000. Lodgepole pine and lodgepole pine x jack pine hybrids appear to occur where mean annual precipitation exceeds 500 mm and the summer moisture index does not exceed 3.
- Conifer-leading mixedwood forests and conifer-dominated (Montane Douglas fir) stands have higher mean annual temperature values than forests dominated by other conifer species (+1.5 to +2.3°C), higher GDD5 values (1000 to 1150), and mean annual precipitation amounts greater than 500 mm.

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[4] *Annual Moisture Index (AMI) is calculated by dividing GDD5 by the MAP. It is a more general indicator of moisture surpluses or deficits.*

[5] *The ability of conifers to grow under harsher conditions than deciduous trees has been attributed to two main factors (Walter 1979): insufficient time for maturation of woody growth on deciduous trees, and the ability of conifer needles to withstand more intense cold and to begin photosynthesis early in spring prior to leaf-out of deciduous species.*

- Deciduous-dominated closed forests and deciduous-leading mixedwood forests have higher mean annual temperature values (+0.2 to 1.1°C) and higher growing degree-day values (1000 to 1300) than conifer-dominated forests. Precipitation tends to be somewhat lower and the frost-free period longer than in conifer-dominated stands.
- Parkland vegetation is associated with mean annual temperature and growing degree-day values slightly higher than those for deciduous-dominated forests. The frost-free period exceeds 100 days (except close to the Front Ranges), and there is a dry period in summer.
- Grassland vegetation is associated with the highest mean annual temperature and growing degree-day values and the lowest mean annual precipitation amounts. The frost-free period is greater than 105 days (except close to the Front Ranges), and there is a pronounced moisture deficit that restricts tree growth to perennially moist sites (e.g., along river floodplains).
- Alpine vegetation is associated with the lowest growing degree-day values and highest mean annual precipitation amounts. The growing season above treeline is too short for conifer needle maturation, and mortality due to dessication occurs.
- Physiographic features at the Subregion level apparently play as important a role as climate in some areas.

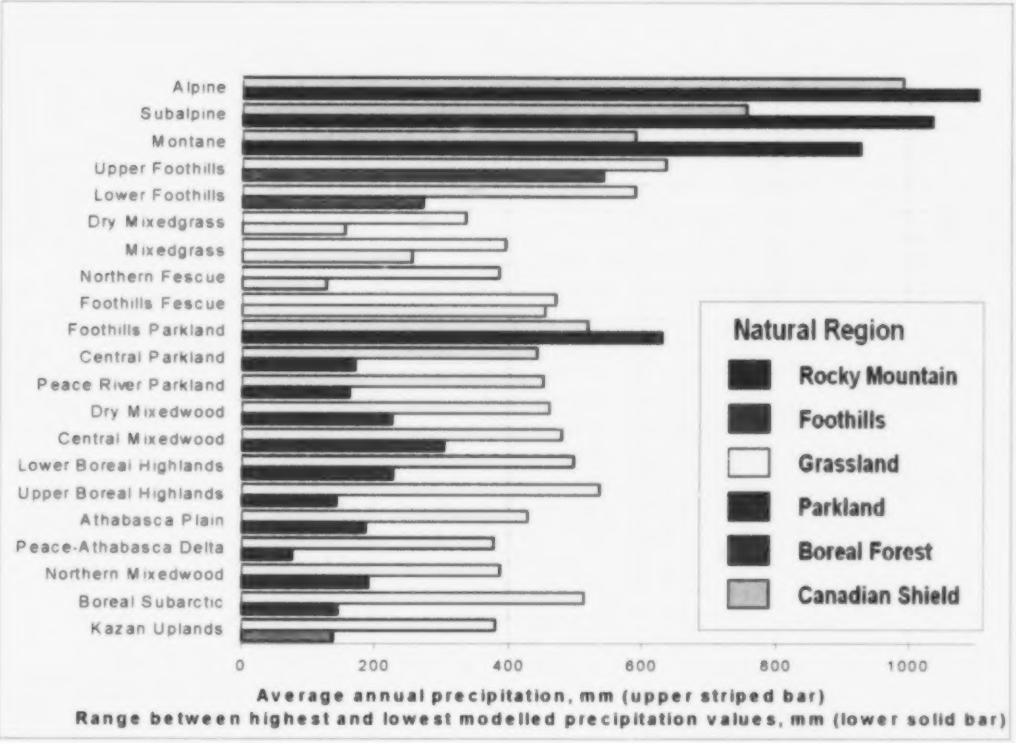


Figure 3-9. Mean annual precipitation, mean (striped bar) and range (solid bar).

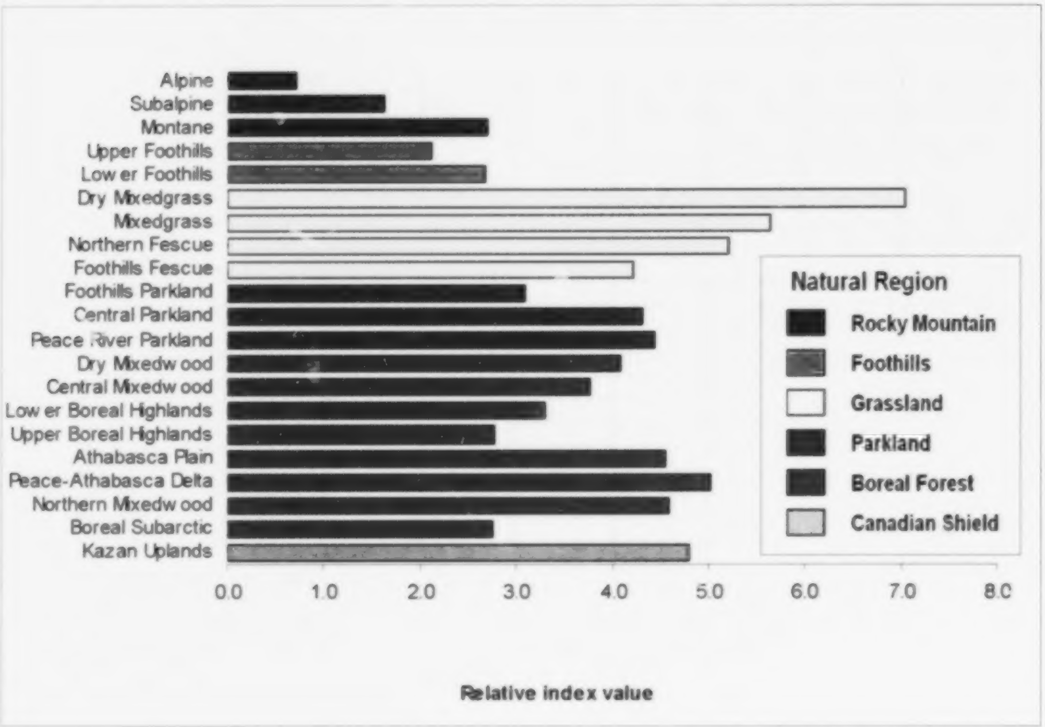


Figure 3-10. Relative summer moisture index.

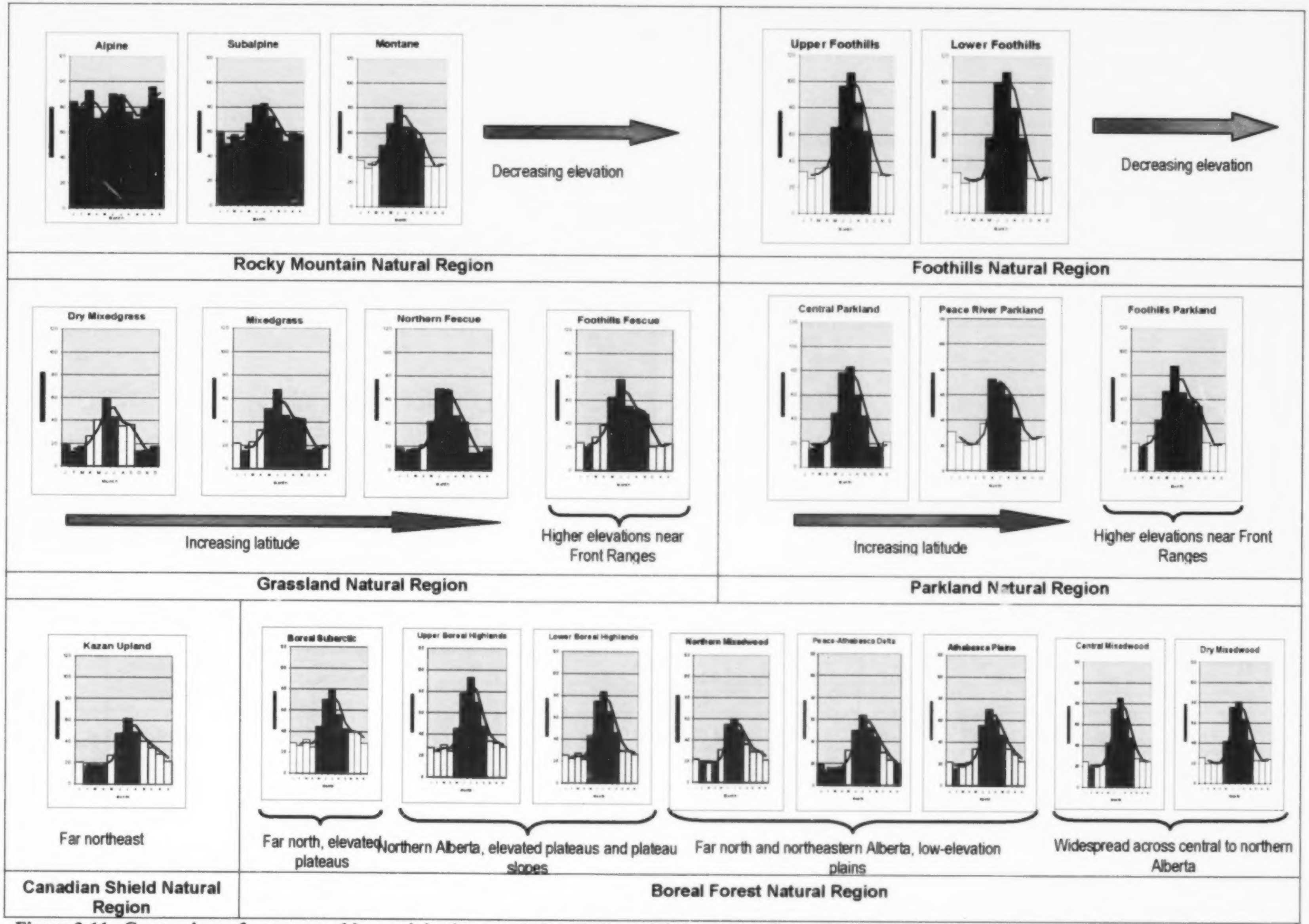


Figure 3-11. Comparison of mean monthly precipitation trends for all Natural Subregions. *(Red = <20 mm, Yellow = 20 to 40 mm, Green = 41 to 60 mm, Light Blue = 61 to 80 mm, Purple = >80 mm. Time axis is January to December. Refer to Part 4 for more detailed bar charts.)*

Table 3-1. Selected climate parameters for Natural Regions.

Ecoclimatic Province	Natural Region	Mean annual temperature (°C) (MAT)	Mean temperature, warmest month (°C) (MTWM)	Mean temperature, coldest month (°C) (MTCM)	Growing degree days >5°C (GDD5)	Continentality	Relative continentality value	Mean annual precipitation (mm)
Cordilleran	Rocky Mountain	-0.4	11.0	-11.7	623	23	0%	798
Boreal–Cordilleran transition	Foothills	1.7	14.3	-12.4	1082	27	21%	603
Grassland	Grassland	4.0	17.8	-11.7	1592	29	36%	374
Grassland–Boreal transition	Parkland	2.3	16.4	-14.4	1391	31	43%	447
Boreal	Boreal	-0.2	15.7	-19.2	1207	35	65%	469
	Canadian Shield	-2.6	16.6	-25.1	1160	42	100%	380

Table 3-2. Selected climate parameters for Natural Subregions.

Ecoclimatic Province	Natural Region	Natural Subregion	Mean annual temperature (°C) (MAT)	Mean temperature, warmest month (°C) (MTWM)	Mean temperature, coldest month (°C) (MTCM)	Mean daily maximum of warmest month(°C)	Mean daily minimum of coldest month (°C)	Growing degree days >5°C (GDD5)	Date at which 100 GDD accumulated (GDD100)	Degree days less than 0°C (DD<0)
Cordilleran	Rocky Mountain	Alpine	-2.4	8.7	-12.6	12.9	-17.2	317	4-Jul	-1866
		Subalpine	-0.1	11.3	-11.7	17.0	-17.0	668	13-Jun	-1550
		Montane	2.3	13.9	-10.0	21.2	-16.1	1017	26-May	-1169
Boreal–Cordilleran transition	Foothills	Upper Foothills	1.3	13.4	-11.6	19.5	-17.8	949	27-May	-1401
		Lower Foothills	1.8	14.7	-12.8	20.9	-18.9	1145	18-May	-1466
Grassland	Grassland	Dry Mixedgrass	4.2	18.5	-12.1	26.2	-17.7	1690	5-May	-1240
		Mixedgrass	4.4	17.6	-10.2	25.1	-15.9	1578	7-May	-1043
		Northern Fescue	2.7	17.2	-14.3	24.3	-19.8	1490	9-May	-1535
		Foothills Fescue	3.9	16.3	-9.7	23.8	-15.7	1388	12-May	-1032
Grassland–Boreal transition	Parkland	Foothills Parkland	3.0	14.7	-9.6	22.1	-16.0	1158	20-May	-1080
		Central Parkland	2.3	16.5	-14.7	23.0	-20.0	1412	10-May	-1585
		Peace River Parkland	1.5	15.9	-15.9	22.4	-21.4	1318	12-May	-1757
Boreal	Boreal Forest	Dry Mixedwood	1.1	15.9	-16.8	22.4	-22.3	1301	13-May	-1872
		Central Mixedwood	0.2	15.9	-18.7	22.0	-24.2	1240	16-May	-2106
		Lower Boreal Highlands	-1.0	15.0	-20.0	20.7	-25.5	1097	22-May	-2333
		Upper Boreal Highlands	-1.5	14.3	-19.9	19.4	-25.3	990	27-May	-2378
		Athabasca Plain	-1.2	17.0	-22.7	22.8	-28.4	1286	18-May	-2614
		Peace–Athabasca Delta	-1.4	17.2	-23.3	23.2	-28.5	1287	20-May	-2660
		Northern Mixedwood	-2.5	15.9	-23.8	22.1	-28.9	1121	25-May	-2882
		Boreal Subarctic	-3.6	13.8	-23.1	18.8	-28.2	869	3-Jun	-2953
	Canadian Shield	Kazan Uplands	-2.6	16.6	-25.1	22.3	-30.0	1160	26-May	-2958

Table 3-2. Selected climate parameters for Natural Subregions (concluded).

Ecoclimatic Province	Natural Region	Natural Subregion	Mean frost-free period (days)	Mean date of last spring frost	Mean date of first fall frost	Continentality	Mean annual precipitation (mm) (MAP)	Growing season precipitation (mm) (GSP)	Percentage of precipitation received during growing season	Summer moisture index (SMI)
Cordilleran	Rocky Mountain	Alpine	40	13-Jul	18-Aug	21	989	472	48%	0.7
		Subalpine	55	30-Jun	22-Aug	23	755	419	56%	1.6
		Montane	64	21-Jun	24-Aug	24	589	382	65%	2.7
Boreal-Cordilleran transition	Foothills	Upper Foothills	79	13-Jun	28-Aug	25	632	450	71%	2.1
		Lower Foothills	94	3-Jun	2-Sep	28	588	430	73%	2.7
Grassland	Grassland	Dry Mixedgrass	113	21-May	11-Sep	31	333	241	72%	7.0
		Mixedgrass	110	25-May	10-Sep	28	394	282	71%	5.6
		Northern Fescue	103	27-May	6-Sep	32	385	287	75%	5.2
		Foothills Fescue	97	1-Jun	5-Sep	26	470	333	71%	4.2
Grassland-Boreal transition	Parkland	Foothills Parkland	76	13-Jun	28-Aug	24	517	377	73%	3.1
		Central Parkland	102	27-May	5-Sep	31	441	330	75%	4.3
		Peace River Parkland	102	28-May	4-Sep	32	450	300	67%	4.4
Boreal	Boreal Forest	Dry Mixedwood	98	30-May	3-Sep	33	461	324	70%	4.1
		Central Mixedwood	97	30-May	2-Sep	35	478	336	70%	3.8
		Lower Boreal Highlands	97	31-May	1-Sep	35	495	334	68%	3.3
		Upper Boreal Highlands	97	1-Jun	2-Sep	34	535	358	67%	2.8
		Athabasca Plain	103	27-May	5-Sep	40	428	287	67%	4.5
		Peace–Athabasca Delta	102	27-May	5-Sep	41	377	257	68%	5.0
		Northern Mixedwood	89	4-Jun	29-Aug	40	387	247	64%	4.6
		Boreal Subarctic	88	7-Jun	29-Aug	37	512	317	62%	2.8
	Canadian Shield	Kazan Uplands	99	30-May	4-Sep	42	380	242	64%	4.8

Table 3-3. Vegetation physiognomy and climatic characteristics.

Major vegetation type	Natural Subregion	Mean annual temperature (°C)	Mean annual precipitation (mm)	Growing degree-days >5°C	Frost-free period (days)	Summer Moisture Index
Vegetation influenced by Regional climate and physiography						
Conifer dominated (black spruce leading), permafrost common	Boreal Subarctic, Northern Mixedwood	<-2.5	400–500	800-1100	80–90	3–5
Conifer dominated (lodgepole pine, lodgepole pine x jack pine, white spruce, Engelmann spruce)	Subalpine, Upper Foothills, Upper Boreal Highlands	-2 to +1	500–800	600-1000	40–95	2–3
Conifer–leading mixedwood	Montane, Lower Foothills	+1.5 to +2.3	550–600	1000-1150	65–95	2–3
Deciduous–leading mixedwood	Central Mixedwood, Dry Mixedwood	+0.2 to +1.1	450–500	1000-1300	95–100	3–4
Parkland (deciduous-grassland mosaic)	Central Parkland, Peace River Parkland, Foothills Parkland	+1.5 to +3.0	440–450 (520 in Higher elevation Foothills Parkland)	1100-1400	>100	3–4.5
Grassland	Dry Mixedgrass, Mixedgrass, Northern Fescue, Foothills Fescue	+2.7 to +4.4	330–400 (470 in Higher elevation Foothills Parkland))	1380-1700	>105 (97 in Foothills Parkland)	4.5–7
Alpine	Alpine	-2.4	989	317	40	0.7
Vegetation influenced by Subregional physiographic characteristics						
Jack pine on coarse textured materials or bedrock	Kazan Uplands, Athabasca Plain	-2.6 to -1.2	380–428	1160-1290	95–105	4.5–5
Floodplains	Peace–Athabasca Delta	-1.4	377	1287	102	5
Seepage zones	Lower Boreal Highlands	-1	495	1097	97	3.3

3.3 SUMMARY OF BIOPHYSICAL CHARACTERISTICS

Table 3-4 presents a summary of biophysical characteristics to enable comparisons between Natural Subregions. Figure 3-12 shows the relative area distributions of all 21 Natural Subregions, and Figure 3-13 shows the average and range of elevation distributions.

The Central and Dry Mixedwood Natural Subregions have a relatively large elevation range because of their extent. The Foothills and Rocky Mountain Natural Regions show significant variability in elevation for two reasons:

1. These Natural Regions are topographically highly variable, from low-elevation, gently rolling foothills and mountain valley bottoms to strongly rolling and inclined higher-elevation foothills and lower mountain slopes, to unvegetated rock and ice barrens at the highest elevations.
2. The modelling process involved the adjustment of elevation-based Subregion lines with reference to latitude. There is a generally linear decrease in the lower elevational limit of the Lower Foothills, Upper Foothills, Subalpine and Alpine Natural Subregions with an increase in latitude. Overstory and understory indicator species distributions were used to determine the approximate rate of decrease.

Part 4 contains further details of Natural Region and Natural Subregion characteristics.

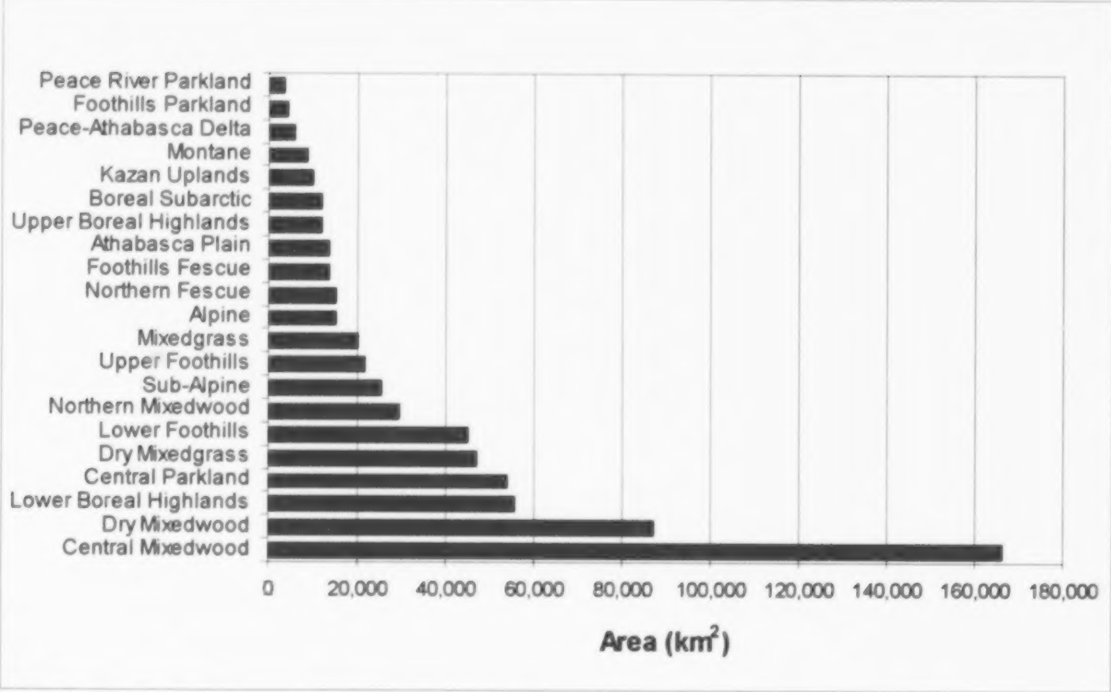


Figure 3-12. Natural Subregion area.

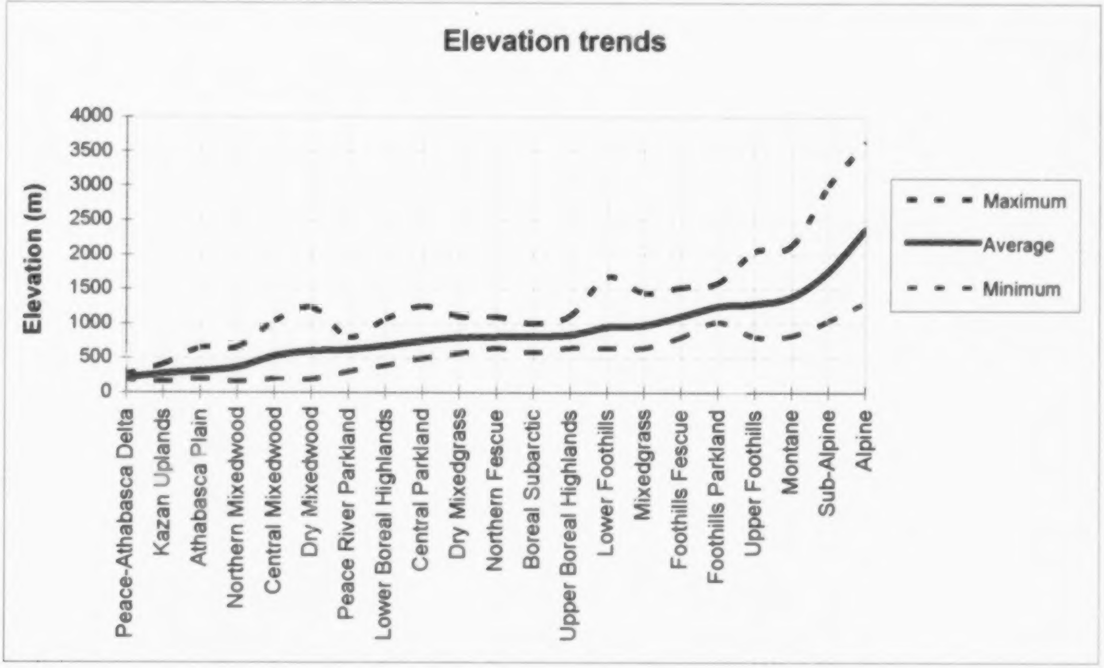


Figure 3-13. Average and range of elevations for Natural Subregions.

Table 3-4. Biophysical characteristics of Natural Subregions. *(Ranges for elevations enclosed in (); values to nearest 25 m.)*

Natural Region	Natural Subregion	Area (km²)	Percent of province	Average elevation (meters above sea level)	Physiography	Major soils	Main vegetation types	Wetlands and water	Land use
Rocky Mountain (6% of province)	Alpine	15,084	2.3	2350 (1900–3650)	Steeply sloping bedrock, colluvium, residual materials, glaciers	Nonsoils, Regosols, Brunisols	Largely nonvegetated; herbaceous meadows, shrublands	Wetlands uncommon; 4% of area as glaciers, snow fields	Conservation, recreation
	Sub-Alpine	25,218	3.8	1750 (1300–2300)	Till, residual materials over rolling and inclined bedrock	Eutric Brunisols	Mixed conifer (lodgepole pine–Engelmann spruce) forests	2% (wetlands), 1% (lakes and streams)	Recreation, forestry, oil and gas, coal mining, minimal grazing
	Montane	8,768	1.3	1400 (825–1850)	Valleys and foothills. Till with significant fluvial deposits.	Mainly Black to Dark gray Chernozems; significant occurrences of Brunisols, Luvisols	Mixed or pure aspen, lodgepole pine, Douglas fir, and white spruce forests, grasslands	2% (wetlands), 1% (lakes, streams)	Recreation, forestry, grazing, major transportation corridors
Foothills (10% of province)	Upper Foothills	21,537	3.3	1300 (950–1750)	Rolling foothills, dissected plateaus, till with colluvium on steeper slopes	Brunisolic Gray Luvisols, Orthic Gray Luvisols. Mesisols and Gleysols in wetlands	Mainly closed coniferous forests (lodgepole pine, lodgepole pine–black spruce, white spruce	10% (wetlands in valleys), < 1% (lakes, streams)	Recreation, oil and gas, coal mining, forestry, minimal grazing
	Lower Foothills	44,899	6.8	950 (650–1625)	Dissected plateaus, rolling uplands. Till with significant fluvial deposits.	Orthic Gray Luvisols, Brunisolic Gray Luvisols. Wetlands are Mesisols and Gleysols.	Mixedwood forests (aspen–lodgepole pine–white spruce)	20% (wetlands in valleys), < 1% (lakes, streams)	Recreation, oil and gas, coal, forestry, grazing, some till cropping at low elevations
Grassland (14% of province)	Dry Mixedgrass	46,937	7.1	800 (550–1100)	Undulating plains. Mainly till with significant lacustrine, fluvial, eolian materials	Brown Chernozems, significant areas of Brown Solonetz. Wetlands are Gleysols	Grasslands (blue grama, needle and thread), shrublands in moister locales	3% (wetlands–marshes or temporary); 2% (lakes, streams)	Oil and gas, grazing, irrigation-based farming
	Mixedgrass	20,072	3.0	975 (650–1450) Highest elevations on Cypress Hills	Undulating plains with some rolling to hummocky areas. Till and lacustrine materials.	Dark Brown Chernozems. Wetlands are Gleysols.	Mainly agricultural; native grasslands are needle and thread, porcupine grass, northern and western wheatgrass, buckbrush shrublands.	5% (wetlands, mainly marshes); 1% (lakes, streams).	Oil and gas, grazing, irrigation-based farming
	Northern Fescue	14,933	2.3	800 (650–1100) Highest elevations to west	Undulating plains and hummocky uplands. Mainly till with significant lacustrine, fluvial, and eolian materials	Dark Brown Chernozems, significant areas of Dark Brown Solonetz. Wetlands are Gleysols.	Plains rough fescue (moist), western porcupine grass (drier). Buckbrush and rose shrublands. Graminoid wetlands.	7% (wetlands, mainly marshes); 3% (lakes, streams)	Oil and gas, grazing, till cropping
	Foothills Fescue	13,623	2.1	1100 (800–1525)	Hummocky and rolling to undulating. Mainly till, significant lacustrine deposits	Mainly Black Chernozems. Wetlands are Gleysols.	Mountain rough fescue on moister sites, western wheatgrass on drier sites. Wet areas often shrubby.	3% (wetlands), 1% (lakes, streams)	Recreation, oil and gas, grazing, till cropping (short-season crops)

Table 3-4. Biophysical characteristics of Natural Subregions (continued). (*Ranges for elevations enclosed in (); values to nearest 25 m.*)

Natural Region	Natural Subregion	Area (km²)	Percent of province	Average elevation (meters above sea level))	Physiography	Major soils	Main vegetation types	Wetlands and water	Land use
Parkland (9% of province)	Foothills Parkland	3,921	0.6	1250 (1025–1525)	Sloping lower foothills and hummocky uplands. Till with significant lacustrine materials in valleys.	Mainly Black Chernozems, some Dark Grey Chernozems. Wetlands are mainly Gleysols.	Aspen forests (continuous and clones). Some areas of dense tall willow (north). Grasslands (mountain rough fescue and Parry's oatgrass) more common on southerly slopes.	4% (wetlands); <1% (lakes, streams)	Recreation, oil and gas, grazing, till cropping (short-season crops)
	Central Parkland	53,706	8.1	750 (500–1250)	Undulating plains, hummocky uplands. Mainly glacial till with lacustrine, fluvial, and eolian inclusions	Mainly Black Chernozems, some Dark Gray Chernozems. Significant Solonetzic soils. Wetlands are Gleysols.	Extensively cultivated. Aspen clones interspersed with grasslands dominated by plains rough fescue; tree cover increases with latitude. Graminoid wetlands.	10% (wetlands, mainly marshes); 2% (lakes, streams)	Oil and gas, till cropping, grazing
	Peace River Parkland	3,120	0.5	625 (300–800)	Gently undulating plains, south-facing slopes of the Peace River. Lacustrine deposits with colluvium on the slopes.	Dark Gray to Black Chernozems (often Solonetzic) with significant Solonetzic and Luvisolic soils. Slopes are Regosols and Dark Brown Chernozems. Wetlands are mainly Gleysols.	Mostly cultivated. Remnant aspen clones and continuous forest, interspersed with sedge–California oat grass–porcupine grass. Jack pine on sands. Graminoid wetlands, often ringed by willow.	6% (wetlands); 2% (lakes, streams)	Oil and gas, till cropping
Boreal Forest (58% of province)	Dry Mixedwood	85,321	12.9	600 (225–1225)	Undulating plains and hummocky uplands. Mainly till with significant lacustrine (Peace Lowlands)	Orthic and Dark Gray Luvisols. Brunisols on sands. Wetlands are Mesisols and Gleysols.	Much of the Natural Subregion has been cultivated. Aspen forests with shrubby understories, some white spruce, jack pine on dry sites. Peatlands common.	15% (wetlands); 3% (lakes, streams, not including Lesser Slave Lake)	Forestry, oil and gas, coal mining, recreation, grazing, till cropping in southern areas
	Central Mixedwood	167,856	25.3	525 (200–1050)	Undulating plains, some hummocky uplands. Equal proportions of till, lacustrine, and fluvial materials	Orthic Gray Luvisols. Brunisols on sands. Wetlands are mainly Mesisols, some Fibrisols, Gleysols	Closed-canopy mixedwood, aspen dominant in early seral stages, white spruce increasing with age. Jack pine common on sandy sites, black spruce (tamarack stands) common on extensive peatlands	40% (wetlands, mainly peatlands); 3% (lakes and streams)	Forestry, oil and gas, coal mining, recreation, grazing in southern areas, minor till cropping, subsistence
	Lower Boreal Highlands	55,615	8.4	675 (400–1050)	Lower slopes of the Northern Alberta Highlands and undulating to hummocky uplands. Mainly till.	Orthic and Gleyed Gray Luvisols. Wetlands are mainly Mesisols with some Gleysols	Early to mid-seral pure or mixed forests (aspen, balsam poplar, black and white spruce, paper birch). Lodgepole pine–jack pine hybrids are common. Open black spruce peatlands; graminoid marshes and willow/marsh reed grass wetlands	30% (wetlands, mainly in the Chinchaga area); 1% (lakes, streams)	Forestry, oil and gas, recreation, subsistence

Table 3-4. Biophysical characteristics of Natural Subregions (concluded). (*Ranges for elevations enclosed in (); values to nearest 25 m.*)

Natural Region	Natural Subregion	Area (km²)	Percent of province	Average elevation (meters above sea level)	Physiography	Major soils	Main vegetation types	Wetlands and water	Land use
Boreal Forest (58% of province)	Upper Boreal Highlands	11,858	1.8	825 (650–1150)	Upper slopes and undulating plateaus of the Northern Alberta Highlands. Mainly till, seepage is common.	Orthic and Gleyed Gray Luvisols, some Brunisolic Gray Luvisols. Wetlands are mainly Mesisols and Organic Cryosols with some Gleysols.	Coniferous forests are dominant at all seral stages. Lodgepole pine–jack pine hybrids are common pioneers occurring with black spruce. Open black spruce stands on wetlands.	35% wetlands; 1-2% (lakes, streams)	Forestry, oil and gas, recreation, subsistence
	Athabasca Plain	13,525	2.0	300 (200–650)	Level to undulating plains with fluvial and eolian deposits, prominent dunes in the west. Strongly hummocky and rolling sandy and gravelly ice-contact materials in the east.	Mainly Dystric Brunisols on well drained materials. Wetlands are mainly Mesisols.	Dry jack pine forests are extensive. Dune areas are largely unvegetated, unique communities that stabilize open sand occur. Wetlands are primarily sedge fens.	20% (wetlands); 3% (lakes, streams)	Recreation, subsistence
	Peace–Athabasca Delta	5,535	0.8	225 (200–250)	Deltaic fluvial and lacustrine deposits; level. Silty and sandy fluvial materials.	Uplands mainly Cumulic Regosols. Wetlands are Gleysols, peatlands are limited.	Aquatic, shoreline, meadow, shrub and marsh vegetation in the lowlands, shrub and forest uplands on terraces, islands and levees. Sedge meadows are characteristic.	20% (wetlands); 40% (shallow lakes and meander channels)	Recreation, subsistence
	Northern Mixedwood	29,513	4.5	350 (150–650)	Level to undulating plains. Fine textured till and lacustrine materials.	Uplands are Orthic Gray and Gleyed Gray Luvisols. Wetlands are Organic Cryosols and Mesisols; permafrost is common.	Wetland vegetation is characteristic (closed, open black spruce). Upland sites (mainly isolated elevated areas and in fluvial areas) forested by pure or mixed aspen, white spruce and black spruce stands.	70% (wetlands); 3% (lakes, streams)	Forestry, oil and gas, recreation, subsistence
	Boreal Subarctic	11,823	1.8	825 (575–1000)	Undulating to rolling plateaus in the Northern Alberta Highlands, mainly till.	Uplands are Orthic Gray and Gleyed Gray Luvisols or Brunisols. Wetlands are Organic Cryosols and Mesisols, permafrost is common.	Open, stunted black spruce forests on organic materials are typical. Predominantly lodgepole pine with some lodgepole pine–jack pine hybrids on drier areas. Wetlands are bogs and fens, often influenced by permafrost features.	60% (wetlands); 2% (lakes)	Oil and gas, recreation (fishing)
Canadian Shield (1% of province)	Kazan Uplands	9,719	1.5	275 (150–400)	Rolling Precambrian shield, local relief to 90 m. Mixture of rock and sandy ice-contact (till) materials.	Non-soils (rock); mainly Dystric Brunisols on sands. Wetlands are mainly Mesisols, permafrost occasional.	Mosaic of rock barrens with pocket communities; open jack pine, birch and aspen occur where there is sufficient soil. Wetlands are primarily bogs.	20% (wetlands); 10% (lakes)	Minor mineral extraction, recreation, subsistence

PART 4. NATURAL REGIONS AND SUBREGIONS OF ALBERTA

Detailed descriptions of six Natural Regions and 21 Natural Subregions are presented in the following order:

4.1. Rocky Mountain Natural Region
- *Alpine Natural Subregion*
- *Subalpine Natural Subregion*
- *Montane Natural Subregion*

4.2. Foothills Natural Region
- *Upper Foothills Natural Subregion*
- *Lower Foothills Natural Subregion*

4.3. Grassland Natural Region
- *Dry Mixedgrass Natural Subregion*
- *Mixedgrass Natural Subregion*
- *Northern Fescue Natural Subregion*
- *Foothills Fescue Natural Subregion*

4.4. Parkland Natural Region
- *Foothills Parkland Natural Subregion*
- *Central Parkland Natural Subregion*
- *Peace River Parkland Natural Subregion*

4.5. Boreal Forest Natural Region
- *Dry Mixedwood Natural Subregion*
- *Central Mixedwood Natural Subregion*
- *Lower Boreal Highlands Natural Subregion*
- *Upper Boreal Highlands Natural Subregion*
- *Athabasca Plain Natural Subregion*
- *Peace-Athabasca Delta Natural Subregion*
- *Northern Mixedwood Natural Subregion*
- *Boreal Subarctic Natural Subregion*

4.6. Canadian Shield Natural Region
- *Kazan Upland Natural Subregion*

Each Natural Region and Natural Subregion description begins with a one or two sentence *theme statement* and a *general description* summarizing the distinguishing ecosystem characteristics. This is followed by a discussion of *climate* attributes and their relevance to vegetation, soils and land uses. The description is concluded with an overview of *vegetation, geology and geomorphology, water and wetland distribution*, and *soils*.

Wildlife attributes are described at the Natural Region level. Although wildlife species often have ranges that extend beyond Natural Region boundaries, some species and species groups are associated with the range of habitats that develop within the climatic regime and physiographic framework of specific Natural Regions, and thus become indicators of these Natural Regions. *Notable features* are described at the Natural Region level for similar reasons.

Land-use patterns are often linked more closely with climatic conditions typical of specific Natural Subregions. Therefore, these patterns are reported only at the Natural Subregion level.

Disturbance factors, particularly fire, are important determinants of vegetation composition and structure in almost every Natural Subregion, and their influence contributes to the vegetation patterns characteristic of each Natural Subregion. Disturbance factors are discussed for specific Natural Subregions where they help to explain vegetation trends within and between Natural Subregions.

Each Natural Subregion description includes a diagram showing the major plant communities and soil types occurring on an array of sites ranging from warm and dry to cold and wet. *Reference* or *characteristic* plant community/soil combinations are represented by shaded boxes, and these terms are described in Part 1 "Concepts". A glossary of terms is also provided in Appendix 3.

A number of standard information sources were consulted during preparation of the

Natural Region and Natural Subregion descriptions. These include the following:

Natural Regions and Subregions

Ecoregions of Alberta. Strong and Leggat (1992).

Natural Regions and Subregions of Alberta (Achuff 1994).

Geology

Geology of Alberta (Hamilton et al. 1999).

Geomorphology

Major physiographic features (e.g., the Interior Plains) are derived from the following sources: Figure 1-2 (found in Part 1) shows these features in a provincial context; Figure 1-3 shows Alberta's major topographic and hydrologic features.

Physiographic Regions of Canada (Bostock 1967).

Physiographic Subdivisions of Alberta (Pettapiece 1986).

Soil Landscapes of Canada–Alberta Version 3 (Pettapiece 2004).

Water Features

Soil Landscapes of Canada–Alberta Version 3 (Canadian Soil Information system (CanSIS) 2004) 1:1M base map information. Figure 1.3 (in Part 1) shows major rivers.

Wetland Types and Distribution

Peatland Inventory of Alberta Phase 1. (Vitt et al. 1996).

Soil Landscapes of Canada–Alberta Version 3 (Pettapiece 2004).

Soils

Soil Landscapes of Canada–Alberta Version 3 (Pettapiece 2004).

The Canadian System of Soil Classification (Soil Classification Working Group 1998).

Vegetation

Numerous site classification and range management guides have been prepared for many of the Natural Subregions. These are referenced in individual Natural Subregions vegetation descriptions, along with other citations that were used in preparing the vegetation descriptions.

Common names used throughout this document follow the *Alberta Plants and Fungi – Master Species List and Species Group Checklists* (Alberta Environmental Protection 1993). Scientific names mostly follow *Flora of Alberta* (Moss 1983), with some updates to be consistent with the taxonomy used by the Alberta Natural Heritage Information Centre. A list of common and scientific names is provided in Appendix 1.

Wildlife Attributes

The following provincial information sources were used by Alberta Natural Heritage Information Centre staff to prepare summaries for two or more Natural Regions. Other sources applicable to specific Natural Regions are cited within the text.

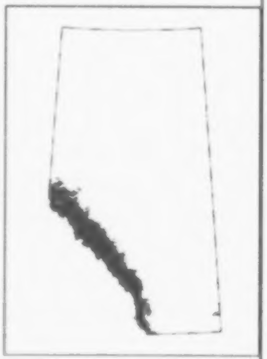
Alberta Natural Heritage Information Centre Datafiles 2005 (Parks and Protected Areas, Alberta Community Development).

A Biophysical Systems Overview for Ecological Reserves Planning in Alberta. (Cottonwood Consultants 1983).

Status of the Woodland Caribou (Rangifer tarandus caribou) in Alberta (Dzus 2001)

Environment Canada website: http://www.speciesatrisk.gc.ca/search/speciesDetails_e.cfm?SpeciesID=34.

4.1 ROCKY MOUNTAIN NATURAL REGION



Mountains, high foothills, and deep glacial valleys define the Rocky Mountain Natural Region. Short, cool summers and cold, snowy winters are typical. At the highest elevations, trees cannot survive; shrubs and herbs grow only in protected places. At lower elevations, coniferous forests are dominant, with grasslands and mixedwood forests on lower elevation warm aspects and valley bottoms.

Total area: 49,070 km^2 (7.4% of province).

Bighorn sheep are found almost entirely within the Natural Region. (Photo: T. Kobliuk)

General Description

The Rocky Mountain Natural Region includes the Alpine, Subalpine and Montane Natural Subregions within and adjacent to the Front Ranges and Main Ranges of the Rocky Mountains. It spans the widest elevational range in Alberta, from a low of about 825 m in northern Montane Natural Subregion valleys to a high of over 3600 m (Mount Columbia) in the Alpine Natural Subregion. Rapid aspect changes and extreme slopes are characteristic of the Alpine Natural Subregion, with less pronounced ridged and rolling landscapes in the Subalpine and Montane Natural Subregions.

Climate

The Rocky Mountain Natural Region has on average the coolest summers, shortest growing season, highest mean annual precipitation and snowiest winters of any Region (Table 3-1, Figure 4-1.1). Within the Natural Region, climates are highly variable; the Montane Natural Subregion receives much less annual precipitation than the Alpine and Subalpine Natural Subregions, and has milder winters than most other Natural Subregions. The high-elevation Alpine and Subalpine Natural Subregions generally receive more annual precipitation and have snowier winters than any other Subregion, and the lower elevation Montane Subregion tends to be drier.

Vegetation

All three Natural Subregions are strongly influenced by Cordilleran climates and by elevation, aspect and substrate. Local regional vegetation and soil patterns clearly reflect these differences, and a complex mosaic of plant communities and soil types has developed in response. The growing season is too short for tree growth in the Alpine Natural Subregion, and plant communities are found on microsites protected from wind and temperature extremes. The highest elevations are essentially barren, with permanent snowfields in some locations.

Open coniferous stands and herbaceous meadows at higher elevations, and closed coniferous stands at lower elevations, characterize the Subalpine Natural Subregion. The Montane Natural Subregion is a mix of grasslands and deciduous–coniferous forests on southerly and westerly aspects, and predominantly coniferous forests on northerly aspects and at higher elevations.

Topography, Geology, Soils and Hydrology

Both topography and geology are highly variable. Steeply inclined to vertical bedrock exposures of Paleozoic to Mesozoic age are typical of the Alpine Natural Subregion. Talus slopes are common along mountain bases, and recent glacial deposits are found in high-elevation valleys. There is considerable north-to-south and east-to-west variation in bedrock types, which controls the physiographic character and plant community distribution of the Subregion. Similar bedrock types underlie the Subalpine Natural Subregion, but exposed bedrock is less common. Colluvial and morainal deposits are both more common than in the Alpine Natural Subregion.

Cretaceous and Tertiary sedimentary rocks underlie the Montane Natural Subregion. Bedrock exposures do occur, but glacial till deposits, fluvial deposits along river valleys, and occasionally highly calcareous wind-deposited materials are prevalent.

There is very little soil development in the Alpine Natural Subregion, reflecting both frequent disturbances that rework soil profiles and low biological activity because of acidic litter and low temperatures. Brunisolic and Luvisolic soils with thin, acidic litter layers are typical in the Subalpine Natural Subregion, and develop in response to high moisture regimes and coniferous forest cover.

In the Montane Natural Subregion, Chernozemic soils often develop under grasslands, thus reflecting a high rate of organic matter incorporation under warm, dry conditions. In contrast, Luvisols form under coniferous stands where moisture is greater, temperatures are cooler and organic matter tends to accumulate as litter rather than mixing with the surface mineral soil horizons.

Appendices 4 and 5 summarize the proportional occurrence of landscape elements, parent materials and soil types.

Glaciers, lakes and rivers account for about 4% of the Alpine Natural Subregion; rivers and small lakes account for 2-3% of the Subalpine and Montane Natural Subregions. Glaciers feed the headwaters of some of Alberta's major rivers that drain into the Saskatchewan and Mackenzie River systems. Wetlands are uncommon to rare features in all three Natural Subregions.

Wildlife Habitats and Populations

The Rocky Mountain Natural Region contains a highly diverse and complex mosaic of habitats which support a correspondingly rich fauna. The most species-rich habitats occur at lower elevations in the eastern and southern part of the Natural Region. An important and significant part of the grizzly bear's range in Alberta occurs within all three Subregions of the Rocky Mountain Natural Region.

The Waterton–West Castle area has a remarkably high number of species that reach their distribution limits there, such as the butterfly Clodius Parnassian, Steller's Jay and wandering shrew. The red-tailed chipmunk and several subspecies of birds and mammals are also found only in the southwest part of the Rocky Mountain Natural Region.

A few species occur only in the northern and central part of the Rocky Mountain Natural Region, including the Willow Ptarmigan and woodland caribou. The mountain ecotype of the woodland caribou typically inhabits alpine areas in the summer, and mature and old forest habitats in the foothills in winter.

Some species range between two or more Natural Subregions within the Rocky Mountain Natural Region. Those that use habitats in both the Alpine and Subalpine Natural Subregions include the Columbian ground squirrel, pika, hoary marmot, mountain goat and bighorn sheep.

The White-tailed Ptarmigan, Gray-crowned Rosy Finch, Horned Lark and American Pipit are restricted to alpine habitats in the nesting season but have a broader range at other times. American Dippers and Harlequin Ducks may be found along or in fast flowing streams.

In the Alpine and upper Subalpine Natural Subregions, rock fields are inhabited by the golden-mantled ground squirrel, yellow pine chipmunk, least chipmunk, pika and hoary marmot. Subalpine forests are inhabited by a number of bird species, some of which are restricted to the Rocky Mountain Natural Region such as the Steller's Jay, Varied Thrush, Clark's Nutcracker and Townsend's Warbler. Clark's Nutcracker is largely restricted to coniferous subalpine forests, where, through seed caching, it plays a significant role in the distribution and regeneration of whitebark pine.

The Hermit Thrush, White-crowned Sparrow, Brewer's Sparrow and Golden-crowned Sparrow are typical species of higher elevations, often in the upper Subalpine Natural Subregion. The Fox Sparrow, MacGillivray's Warbler and Wilson's Warbler are common in dense avalanche slope vegetation. The Black Swift nests locally on cliff faces kept moist by cascading water. Aspen stands provide habitat for a variety of birds including the MacGillivray's Warbler, Warbling Vireo, White-crowned Sparrow and Lazuli Bunting.

Wet meadows and streamside shrubbery throughout the Rocky Mountain Natural Region are productive small mammal habitats. Here, species such as the long-tailed vole, northern bog lemming, heather vole and Richardson's water vole (the latter rare in Alberta) may be found.

The Montane Natural Subregion has a number of unique habitats and wildlife species assemblages. Douglas fir–limber pine habitats in the Montane Subregion are typically inhabited by Blue Grouse, Mountain Chickadee, Hammond's Flycatcher, Clark's Nutcracker and Columbian ground squirrel. They are important wintering areas for mule deer and wapiti.

Douglas fir and lodgepole pine forests in the Montane Subregion provide habitat for the Yellow-rumped Warbler (Audubon's subspecies), Dark-eyed Junco (Oregon subspecies), Chipping Sparrow, Red Crossbill, Pine Siskin and red squirrel. Mixedwood forests support a diverse avian community, including Alder Flycatcher, Swainson's Thrush, Warbling Vireo, Calliope and Rufous Hummingbirds, Tennessee Warbler, Orange-crowned Warbler, Northern Waterthrush, MacGillivray's Warbler, American Redstart and Western Tanager.

Wetlands, mixed woods, and shrubbery associated with beaver ponds, streams and lakes in the Montane Natural Subregion support a diverse array of wildlife species. The Barrow's Goldeneye, Common Snipe, Red-winged Blackbird, Common Yellowthroat, Lincoln's Sparrow, beaver, muskrat, western toad, spotted frog and long-toed salamander occur in open water and marsh habitats. Spotted frog and long-toed salamander occurrences are mostly restricted to the Rocky Mountain Natural Region.

The Cypress Hills outlier of the Montane Natural Subregion has a unique fauna, including some endemic forms and subspecies which occur nowhere else in Canada. One taxon, the Mearn's subspecies of the Dark-eyed Junco, occurs in Canada only in the Cypress Hills. Other rare and uncommon species of the Cypress Hills include leopard frog, Broad-winged Hawk, Ring-necked Duck, Lazuli Bunting, Turkey Vulture, Poorwill and Baird's Sparrow.

Some species that are typical of the western Montane Natural Subregion do not occur in the Cypress Hills, such as the Mountain Chickadee and Blue Grouse, possibly because of geographic isolation. Hawthorn thickets, unique in Alberta, grow along streams and on hillsides, and are home to the Dusky Flycatcher, MacGillivray's Warbler, Veery, White-crowned Sparrow and Common Yellowthroat.

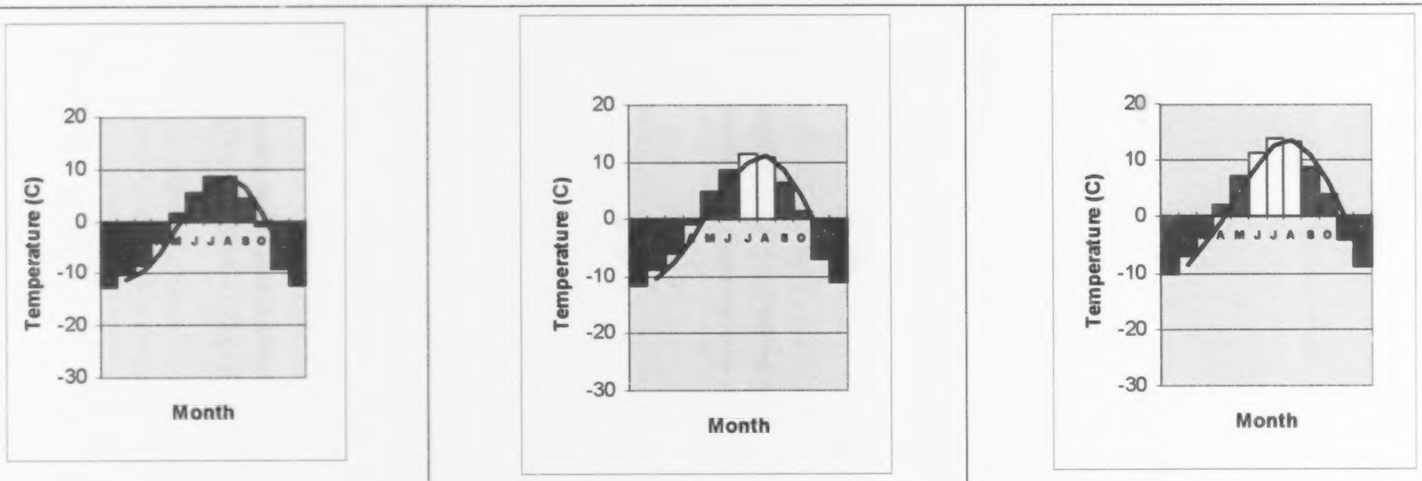
Native fish species of the Rocky Mountain Natural Subregion include lake trout, bull trout, mountain sucker (in the south), and local populations of rainbow trout and cutthroat trout.

Notable Features

Unique geologic and botanical features and wildlife species of special concern are associated with the Rocky Mountain Natural Region. These are described below.

- *Extremely calcareous loess (windblown glacial silt)* deposits are found at the mouth of the Athabasca River Valley east of the Jasper airstrip and on to Hinton. Nationally unique soil types have developed on these deposits and are associated with some unusual plant community types.
- *Permafrost features* such as patterned ground are found in a few places in the Alpine Natural Subregion, notably in the Plateau Mountain area.
- *Glaciers and snowfields* at the highest elevations of the Central Ranges contribute greatly to year-round flows of major rivers that drain into the Mackenzie and Saskatchewan basins.
- *The Cypress Hills* are the highest Canadian landscape feature between Labrador and the Rocky Mountains. At higher elevations on northerly slopes, conditions are cool and moist enough to support forest and grassland communities like those found in the Rocky Mountains several hundred kilometers to the west. For these reasons, the Cypress Hills plateau is classified as an outlier of the Montane Natural Subregion.
- *Grizzly bear,* designated as "Species of Special Concern" by COSEWIC.
- *Woodland caribou,* designated as "Threatened" by the Government of Alberta and COSEWIC.
- *Flora.* More than 300 rare plant species (about 65% of Alberta's rare vascular plants) occur in the Rocky Mountain Natural Region, and about 140 are restricted in Alberta to this Region. The Waterton–Crowsnest area in southwestern Alberta has the highest concentration of rare plants in the province, and the northern Rocky Mountains (Jasper National Park, Cardinal Divide and north) is another area of high rare plant concentration (Kershaw et al. 2001). The Crowsnest Pass–Waterton area harbors some provincially rare plant species and community types because of milder Pacific climatic influences.

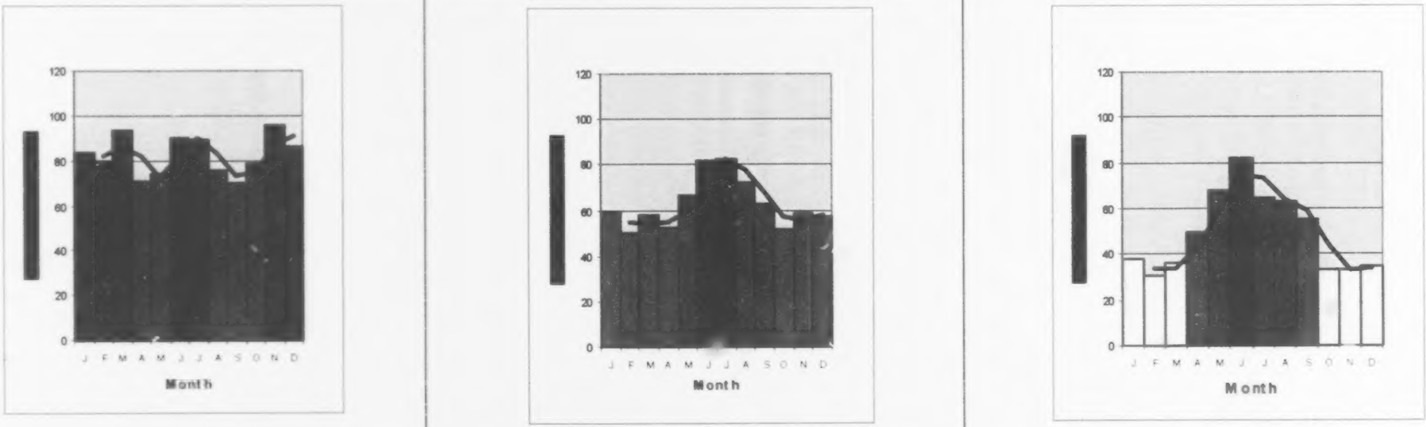
Glaciers and snowfields are a significant feature of the Natural Region. (Photo: T. Kobliuk)



Alpine Natural Subregion
Mean Monthly Temperature (MAT –2.4˚C)

Subalpine Natural Subregion
Mean Monthly Temperature (MAT –0.1˚C)

Montane Natural Subregion
Mean Monthly Temperature (MAT +2.3˚C)



Alpine Natural Subregion
Mean Monthly Precipitation (MAP 989 mm)

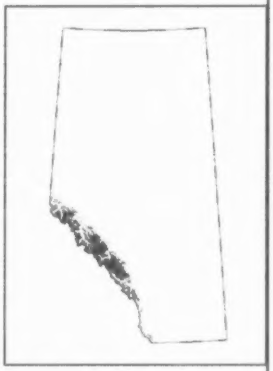
Subalpine Natural Subregion
Mean Monthly Precipitation (MAP 755 mm)

Montane Natural Subregion
Mean Monthly Precipitation (MAP 589 mm)

Figure 4-1.1. Rocky Mountain Natural Region climate data summaries. (*Refer to footnotes in Figures 3-8 and 3-11 for color scheme explanations. MAP= Mean Annual Precipitation, MAT= Mean Annual Temperature.*)

4.1.1 Alpine Natural Subregion

Theme



The Alpine Natural Subregion is a land of mountains, glaciers and snowfields extending north to south along the Continental Divide. Steeply inclined to vertical bedrock exposures, short, cold summers, strong winds and high snowfalls prevent tree growth and limit plant growth to low-growing shrubs and herbs in protected areas.

Overview (Photo: T. Kobliuk)

Total area: 15,084 km2 (31% of Rocky Mountain Natural Region).

Average elevation: 2350 m (range 1900-3650 m).

Key Features

- Mountains, glaciers and snowfields.
- Trees absent except for dwarfed individuals or scattered islands in sheltered locations at lower elevations.
- Harsh climates.
- Highly variable microclimates produced by differing aspects, wind exposures, elevations, substrates, and snow deposition patterns produce complex vegetation patterns.

White mountain avens is a common alpine plant of dry sites. (Photo: L. Allen)

General Description

The Alpine Natural Subregion occupies the highest lands in Alberta, and includes all areas above tree line in the Rocky Mountain Front and Main Ranges. It occurs at elevations as low as 1900 m in the north and as high as the summit of Mt. Columbia at just under 3650 m. Its lower boundary with the Subalpine Natural Subregion decreases with latitude at a rate of about 0.5 m/km northward. A cold, harsh climate along with steep and unstable rocky substrates, active glaciers and permanent snowfields limit plant growth and soil development to sheltered locales.

Climate

The Alpine Natural Subregion has the coldest summers, shortest growing season and highest snowfall of any Subregion in Alberta (Table 3-2) for annual and seasonal climatic statistics). Environment Canada 1961–1990 climate normals indicate that average precipitation amounts tend to be greater in the Central Ranges as compared to the Front Ranges. Banff, in the Front Ranges and within the Montane Natural Subregion, receives average annual precipitation of about 470 mm. Lake Louise, at the transition point between the Montane and Subalpine Natural Subregions, receives about 600 mm. Permanent snowfields and glaciers occur where snowfall exceeds snowmelt and ablation.

Strong winds are characteristic of the Alpine Natural Subregion, and control snow deposition, evapotranspiration and temperature regime (Achuff 1994; Strong and Leggat 1992).

Topography, parent material and regional climate interact to produce an exceptionally complex mosaic of microclimates. On exposed bedrock or in areas that are perennially snow or ice covered, only non-vascular plants can survive.

Warmer, moister microclimates (e.g., rockfields and protected crevices), or areas where snow protects plants through the winter but melts for a few weeks in summer, provide habitats ranging in size from a few square centimetres to several hectares. Extensive vegetated areas are unusual but do occur, such as the expanse of alpine meadows in the Cardinal Divide–Tripoli Ridge area.

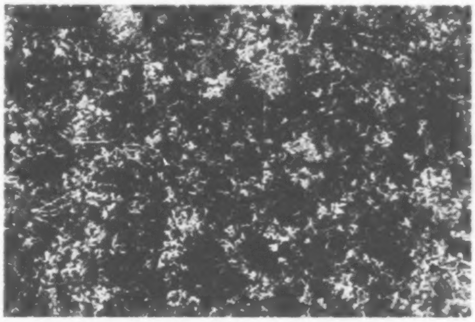
Vegetation

The Alpine Natural Subregion is characterized by low-growing vegetation and a complex array of sites produced by the interaction of elevation, topography, substrate, latitude, and regional to local climates. The resulting plant communities are correspondingly variable, and community structure and distribution patterns are not comprehensively understood. There are apparent south-to-north and east-to-west variations in species composition, as indicated by distribution maps in Moss (1983).

Strong and Leggat (1992), Achuff (1994) and Willoughby and Alexander (2003) have reviewed the work of other researchers and their syntheses are summarized here. The diagram in Figure 4-1.2 is derived from Strong and Leggat (1992).

Three zones may be recognized within the Alpine Natural Subregion. The "lower" zone is vegetated by willow and dwarf or bog birch communities, with a few scattered dwarf trees or krummholz ("crooked wood") islands in sheltered locales. Heather and sedge snowbed communities occupy the "middle" zone. The "upper" zone is sparsely vegetated due to cold temperatures and high winds, and lichens growing on bedrock are often the only vegetative life form. Unlike most other Natural Subregions in Alberta, fire does not exert a strong influence on plant community development in this Subregion.

On the driest, coldest and most exposed locations, only lichens grow on rock faces or mineral soils in a "stonefield–lichen" complex. In places where snow deposits are shallow and sites are dry because of wind or aspect, communities composed of very low-growing tussock or cushion-form plants develop, with white mountain avens, bog–sedge and alpine fescues as common associates. Stonefield–lichen complexes and mountain avens communities form the most extensive plant cover. Mountain avens communities on dry sites are displayed as the characteristic site in Figure 4-1.2.



Lichen community (Photo: L. Allen)

Dwarf shrub–heath communities occur on sites that have an average snowpack. Mountain–heather communities are usually associated with imperfectly to moderately well drained sites, and slightly better drained locales support heather communities. In Figure 4-1.2, heather communities on moderately well to imperfectly drained soils are shown as the reference site.

Areas of deep snow accumulation that do not melt until mid summer usually support black alpine sedge–forb snowbed communities on poorly drained Gleysolic or Regosolic soils. In areas that are moist but not snow covered for as long (e.g., streamsides and seeps below snowbeds), willow–bog birch shrublands and diverse, colourful alpine meadow communities with a variety of grasses and forbs may be found.

Colourful blooms in a moist alpine meadow.
(Photo: L. Allen)

South of the Crowsnest Pass, mountain-heathers are uncommon, and heathers are more restricted in their distribution and occurrence. Communities that include bear-grass and other species that do not occur elsewhere in Alberta are found in the extreme southwest corner of Alberta. A few Arctic tundra species, such as white mountain avens, have their southernmost distributions in the more northerly alpine meadows and rocklands in Alberta.

Geology and Geomorphology

Steep, upthrust limestones, dolomites, conglomerates, shales and siltstones of Paleozoic and Mesozoic age geologically define the Alpine Natural Subregion. Exposed bedrock is dominant. Surficial materials occur over about 40 percent of the area, and are mainly colluvial deposits or thin glacial deposits. Rock glaciers occur from Kananaskis Country to Jasper National Park, and periglacial landforms (e.g., lateral and terminal moraines) are associated with glaciers in Banff and Jasper National Parks. Appendix 4 summarizes the proportional occurrence of landscape elements and parent materials in the Alpine Natural Subregion.

Water and Wetlands

Water exists as glaciers and snowfields that cover about 4 percent of the area, mainly along the continental divide. Alpine lakes and the headwaters of major rivers are fed by glacial meltwaters. Wetlands are uncommon and typically very small.

Soils

Soil development is weak due to harsh climates and unstable parent materials. Nonsoils dominate in this Subregion. Eutric Brunisols are the principal soils reflecting mainly calcareous rock substrates, but there are significant occurrences of Dystric Brunisols associated with ericaceous vegetation and acidic parent materials. Regosols are very common, with Gleysols in wet locations. Appendix 5 summarizes the proportional occurrence of soil types in the Alpine Natural Subregion.

Land Uses

The Alpine Natural Subregion is largely protected within National Parks and Provincial Parks and Wilderness Areas. It is an extremely important watershed and provides valuable wildlife habitat and varied recreational opportunities.

Mountain heather-dominated community (photo: L. Allen).

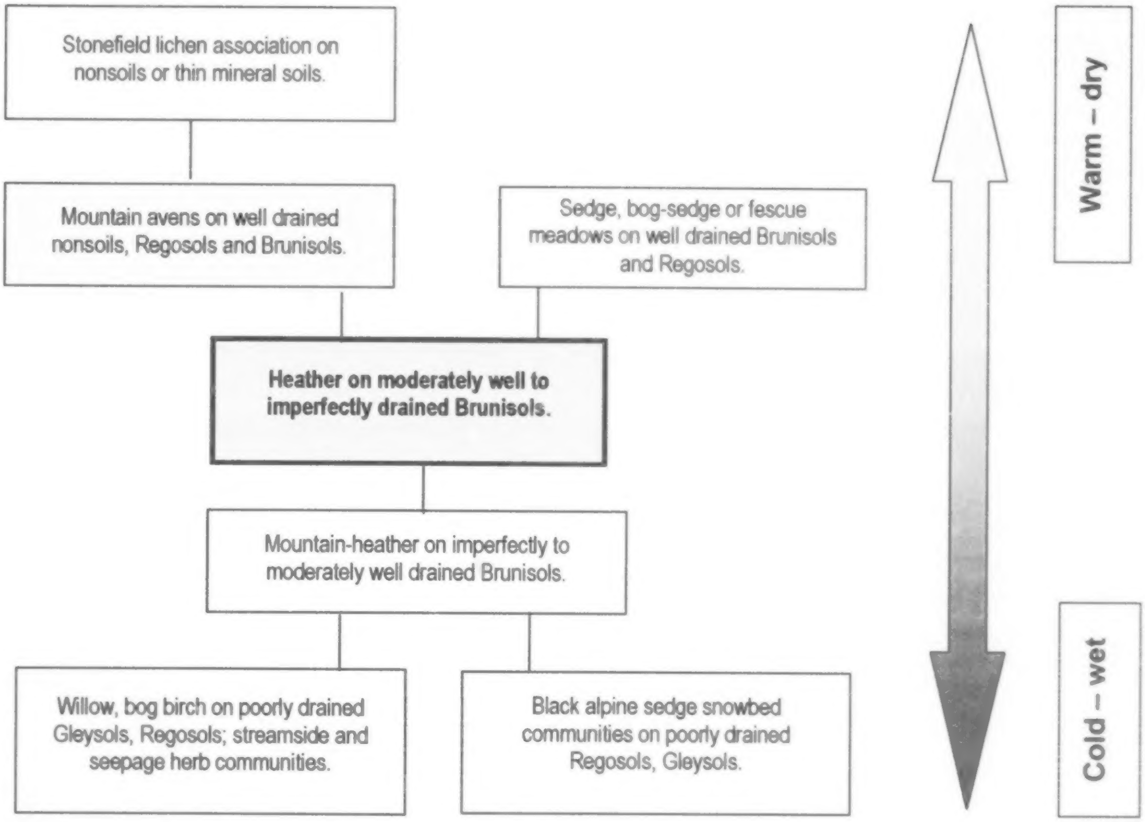
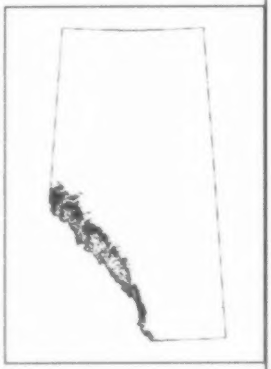

Stonefield lichen association on nonsoils or thin mineral soils.
Mountain avens on well drained nonsoils, Regosols and Brunisols.
Sedge, bog-sedge or fescue meadows on well drained Brunisols and Regosols.
Heather on moderately well to imperfectly drained Brunisols.
Mountain-heather on imperfectly to moderately well drained Brunisols.
Willow, bog birch on poorly drained Gleysols, Regosols; streamside and seepage herb communities.
Black alpine sedge snowbed communities on poorly drained Regosols, Gleysols.
Warm – dry
Cold – wet

Figure 4-1.2. Common ecosystems arranged along environmental gradient, Alpine Natural Subregion.
(Reference site is in blue-shaded box in boldface type; characteristic site is in yellow-shaded box.)

4.1.2 Subalpine Natural Subregion

Theme



The Subalpine Natural Subregion occurs at high elevations below the Alpine Natural Subregion on rolling to inclined shallow morainal and residual materials over bedrock. Short, cool summers and high winter snowfalls are characteristic. Open stands of Engelmann spruce and subalpine fir are dominant at higher elevations, with stunted individuals and krummholz islands near treeline; closed lodgepole pine forests are prevalent at lower elevations.

Key Features

- Occurs on midslopes of the Front Ranges and lower slopes of the western Central Ranges.
- Coniferous forests are dominant throughout the Subregion; open Engelmann spruce, subalpine fir and subalpine larch forests interspersed with herb-rich meadows occur at higher elevations and young fire-successional lodgepole pine stands at lower elevations.
- Highly variable microclimates produced by differing aspects, wind exposures, elevations and substrates.

Overview (Photo: A. Landals)

Total area: 25,218 km² (51% of Rocky Mountain Natural Region).

Average elevation: 2350 m (range 1300-2300 m).

White-flowered rhododendron is an indicator of Subalpine climatic influences. (Photo: L. Allen)

General Description

The Subalpine Natural Subregion includes all areas below the Alpine Natural Subregion and above the Montane Natural Subregion south of the Bow River, above the Upper Foothills Natural Subregion north of the Bow River, and within the lower valleys sides and bottoms of the Rocky Mountain Main Ranges. The Subalpine–Upper Foothills boundary occurs at approximately 1350 m in the Grande Prairie area, rising to approximately 1700 m along the Bow River Corridor.

South of the Bow River, the Subalpine Natural Subregion borders the Montane Natural Subregion, and this boundary occurs at about 1600 m. Its lower boundary with the Upper Foothills Natural Subregion decreases with latitude at a rate of about 0.6 m per kilometre northward; its upper boundary with the Alpine Natural Subregion decreases with latitude at a rate of about 0.5 m per kilometre northward. Climatic conditions are somewhat more moderate than the Alpine Natural Subregion, allowing the growth of trees;

however, the climate is still cold year-round and tree growth rates are generally slow.

Climate

Short, cool, wet summers and long, cold winters with heavy snows are typical of the Subalpine Natural Subregion. It receives more year-round precipitation on average than any Natural Subregion except for the Alpine (refer to Table 3-2 in Part 3 for annual and seasonal climatic statistics). As in the Alpine Natural Subregion, precipitation amounts in the Subalpine Natural Subregion tend to be greater in the Central Ranges compared to the Front Ranges, and winter temperatures in the Central Ranges tend to be somewhat more moderate than along the eastern slopes of the Front Ranges.

Average winter temperatures in the Subalpine Natural Subregion and the adjacent Upper Foothills Natural Subregion are slightly higher than the Lower Foothills Natural Subregion because the influence of continental polar cold air masses does not last as long. Chinooks are an infrequent influence in the Subalpine Natural Subregion, except in major east-west mountain valleys.

Location can play a significant role in diurnal temperature variations and explains in part the very large range in monthly mean, maximum and minimum temperature values, and frost-free periods for the Subalpine Natural Subregion (Appendix 2). Where the Subalpine Natural Subregion occupies valley bottom and lower slope terrain, daytime temperatures in summer are usually warmer in valleys than on upper slopes. However, cold air can pool in valley bottoms at night, reducing the growing season significantly and retarding or preventing tree growth in some locales where frost may occur at any time.

At higher elevations near the Subalpine–Alpine boundary, the growing season is short and widely spaced stunted trees grow individually or as krummholz islands (dense clumps of stunted and twisted trees). Wind-carried ice and snow particles can abrade plant tissues, and are a major factor in producing krummholz at the Alpine–Subalpine boundary.

Vegetation

Vegetation patterns in the Subalpine Natural Subregion are influenced by elevation, topography and latitude. Achuff (1994) and Strong and Leggat (1992) describe two elevation zones. The Lower Subalpine zone is characterized by closed fire-origin lodgepole pine forests with Engelmann spruce and subalpine fir; Engelmann spruce hybridizes with white spruce at lower elevations.

Forests become open and stunted near the upper limits of the Subalpine. (Photo: L. Allen)

The Upper Subalpine zone is forested by closed Engelmann spruce–subalpine fir forests that become more open near the forest line and include subalpine larch and whitebark pine. Krummholz islands define the upper limits of the Subalpine Natural Subregion.

There are also significant differences in vegetation structure and composition from south to north, and two latitudinal divisions may be recognized: the *south-central mountains* south of the North Saskatchewan River, and the *northern mountains* north of the North Saskatchewan River. Figure 4-1.3 shows the general sequence of ecosystems in both areas, arranged along a moisture and nutrient gradient.

Vegetation of the south-central mountains

At low to middle elevations in the south-central mountains, dry sites, often on south- or west-facing slopes, are forested by lodgepole pine with an understory of bearberry and hairy wild rye on loamy Brunisols and Luvisols, or by bearberry–mountain rough fescue grasslands on Brunisols and Chernozems.

Lodgepole pine, Engelmann spruce, and subalpine fir stands with understories of false azalea, grouseberry, Canada buffaloberry, low bilberry, hairy wild rye, pine reed grass and feathermosses occur with medium textured Brunisols on mesic sites. The short fire return interval is responsible for the dominance of young to mid-seral lodgepole pine stands.

False azalea, grouseberry, white-flowered rhododendron and Engelmann spruce are indicators of Subalpine climatic influences. These are used to help define the Subalpine–Upper Foothills and Subalpine–Montane Natural Subregion boundaries.

False azalea (Photo: L. Allen)

On moister sites, thimbleberry may also be found in the understory, and is indicative of Montane climatic influences. Luvisols and Gleyed subgroups are associated with these sites. Sedge fens, dwarf birch–tufted hair grass communities, and Engelmann spruce–horsetail communities occur on very moist to wet sites with Organic, Regosolic and Gleysolic soils.

At upper elevations in the south-central mountains, cooler, wetter conditions have resulted in a longer fire return interval, and mature Engelmann spruce–subalpine fir forests are typical. Heather, mountain-heather, willow, grouseberry and feathermosses are typical understory associates. These sites are nutrient-poor and soils are usually thin, stony Brunisols over bedrock. Subalpine larch and whitebark pine occur with subalpine fir and Engelmann spruce in open stands near treeline.

Grouseberry (Photo: L. Allen)

Vegetation of the northern mountains

Similar communities occur in the northern mountains, but there are a few differences in species composition. White-flowered rhododendron is more common in the north than grouseberry. Black spruce, dwarf bramble, bog cranberry, common Labrador tea and tamarack are increasingly common north of the Red Deer River drainage but uncommon to rare in the south-central mountains. Hairy wild rye replaces pine reed grass and mountain rough fescue under lodgepole pine stands or in grasslands in the northern mountains.

Subalpine larch and whitebark pine are uncommon north of the North Saskatchewan drainage. Low bilberry is common in the south–central mountains, but uncommon in the northern mountains. In the latter, tall bilberry is a common and often abundant species. Extensive Barratt's willow shrublands are found in valleys of the northern mountains where cold air drainage has resulted in a microclimate too cool for trees in valley bottoms. Plant community summaries are presented in Archibald et al. (1996) and Beckingham et al. (1996) for the south-central and northern mountains, respectively. Willoughby and Alexander (2003) describe numerous shrub and grassland communities for both areas (not included in this discussion or in Figure 4-1.3).

Geology and Geomorphology

Mesozoic and Paleozoic limestones and dolomites form the underlying bedrock, along with quartzites, shales and sandstones. Surficial materials are mainly a mixture of coarse morainal deposits, but about 30% of the area, primarily the steeper slopes, are colluvial materials. Fluvial and glaciofluvial deposits occur mainly along major rivers. Bedrock exposures are common. Appendix 4 summarizes the proportional occurrence of landscape elements and parent materials in the Subalpine Natural Subregion.

Colluvium is common on steeper slopes in the Subalpine. (Photo: L. Allen)

Water and Wetlands

Small lakes occur infrequently throughout the Subalpine Natural Subregion, and major rivers such as the Smoky, Athabasca, North Saskatchewan, Bow and Crowsnest Rivers flow through the valleys; however, open water occupies only about 1% of the total area. Wetlands are uncommon, accounting for only 2% of the Subregion area, and occur in valley bottom locations. Seepage is common along lower valley slopes.

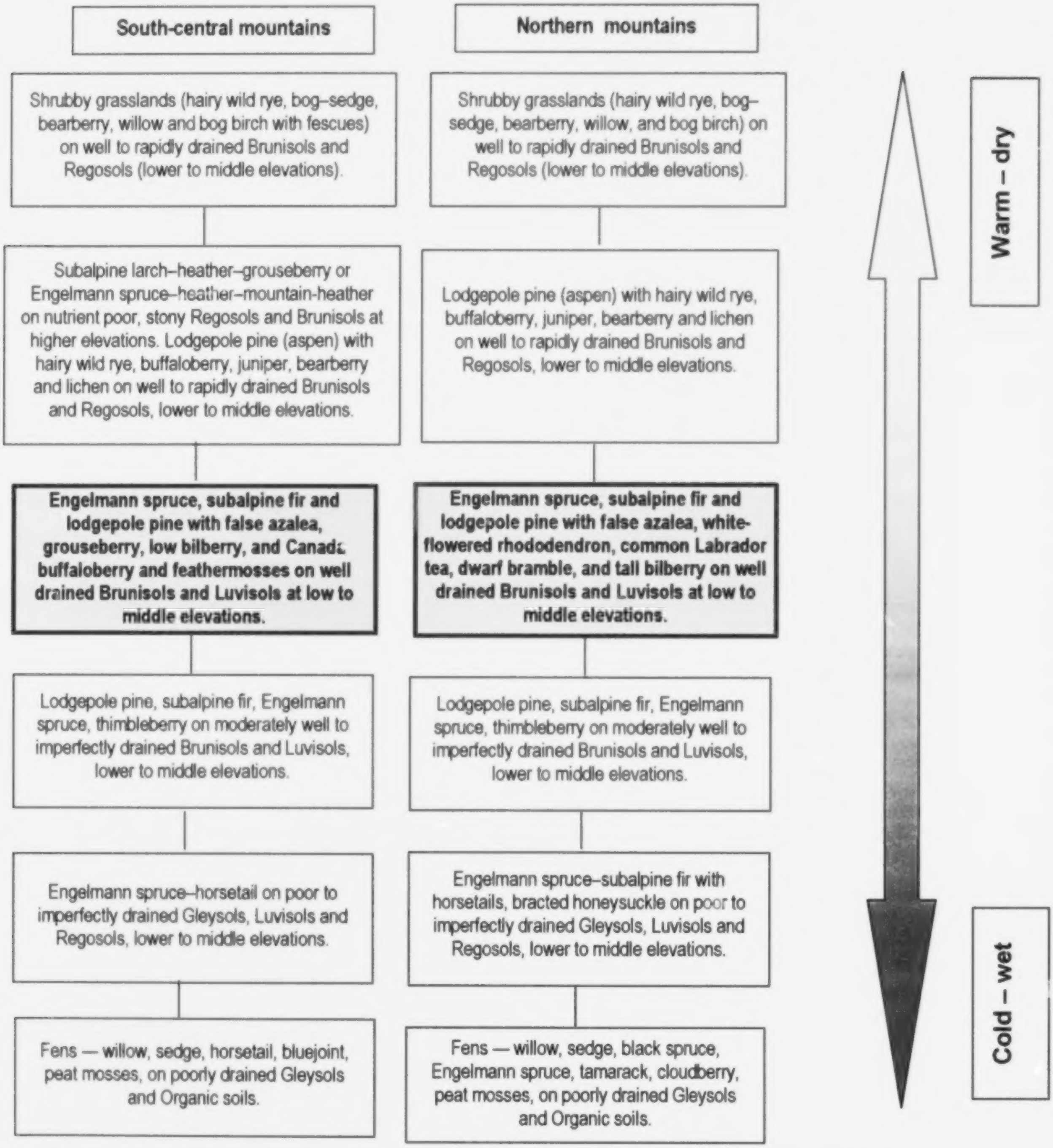
Soils

Cold temperatures, high precipitation and coarse, often unstable parent materials over steeply sloping bedrock contribute to the development of Eutric and Dystric Brunisols; Regosols and nonsoils (e.g., colluvium, exposed bedrock) are also common. About 25% of the area is occupied by less pronounced terrain and somewhat finer textured soils on which Orthic and Brunisolic Gray Luvisols have developed. Wetland soils are usually Gleysols, but Organic soils also occur. Appendix 5 summarizes the proportional occurrence of soil types in the Subalpine Natural Subregion.

Land Uses

The Subalpine Natural Subregion provides valuable wildlife habitat and recreational opportunities. Timber harvesting is a significant activity but productivity is low, regeneration is slow, and harvesting and regeneration can be difficult because of steep slopes. Cattle grazing occurs on native rangelands and disturbed areas. Intensive oil and gas exploration and development and coal mining occur mainly north of the North Saskatchewan River.

Engelmann spruce with an understory dominated by white-flowered rhododendron is a common ecosystem in the northern and central areas of the Subalpine Subregion. (Photo: L. Allen)



South-central mountains

Shrubby grasslands (hairy wild rye, bog–sedge, bearberry, willow and bog birch with fescues) on well to rapidly drained Brunisols and Regosols (lower to middle elevations).

Subalpine larch–heather–grouseberry or Engelmann spruce–heather–mountain-heather on nutrient poor, stony Regosols and Brunisols at higher elevations. Lodgepole pine (aspen) with hairy wild rye, buffaloberry, juniper, bearberry and lichen on well to rapidly drained Brunisols and Regosols, lower to middle elevations.

Engelmann spruce, subalpine fir and lodgepole pine with false azalea, grouseberry, low bilberry, and Canada buffaloberry and feathermosses on well drained Brunisols and Luvisols at low to middle elevations.

Lodgepole pine, subalpine fir, Engelmann spruce, thimbleberry on moderately well to imperfectly drained Brunisols and Luvisols, lower to middle elevations.

Engelmann spruce–horsetail on poor to imperfectly drained Gleysols, Luvisols and Regosols, lower to middle elevations.

Fens — willow, sedge, horsetail, bluejoint, peat mosses, on poorly drained Gleysols and Organic soils.

Northern mountains

Shrubby grasslands (hairy wild rye, bog–sedge, bearberry, willow, and bog birch) on well to rapidly drained Brunisols and Regosols (lower to middle elevations).

Lodgepole pine (aspen) with hairy wild rye, buffaloberry, juniper, bearberry and lichen on well to rapidly drained Brunisols and Regosols, lower to middle elevations.

Engelmann spruce, subalpine fir and lodgepole pine with false azalea, white-flowered rhododendron, common Labrador tea, dwarf bramble, and tall bilberry on well drained Brunisols and Luvisols at low to middle elevations.

Lodgepole pine, subalpine fir, Engelmann spruce, thimbleberry on moderately well to imperfectly drained Brunisols and Luvisols, lower to middle elevations.

Engelmann spruce–subalpine fir with horsetails, bracted honeysuckle on poor to imperfectly drained Gleysols, Luvisols and Regosols, lower to middle elevations.

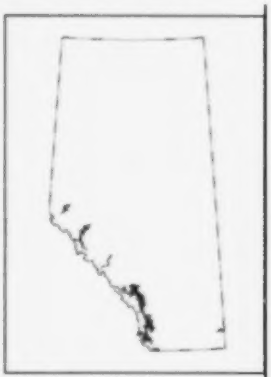
Fens — willow, sedge, black spruce, Engelmann spruce, tamarack, cloudberry, peat mosses, on poorly drained Gleysols and Organic soils.

Figure 4-1.3. Common ecosystems arranged along environmental gradient, Subalpine Natural Subregion. (*Reference sites are in blue-shaded boxes in boldface type.*)

4.1.3 Montane Natural Subregion

Theme

The Montane Natural Subregion, a land of striking contrasts, occurs at lower elevations along the Front Ranges. It extends west into the Main Ranges along major mountain valleys and south along the Porcupine Hills. The upper elevations of the eastern Cypress Hills also belong to this Natural Subregion.



Summers are cool, but winters are warmer than almost anywhere else in Alberta. Lodgepole pine, Douglas fir and aspen stands occur on easterly and northerly aspects and grasslands on southerly and westerly aspect at lower elevations. Closed mixedwood and coniferous forests dominated by lodgepole pine occur at higher elevations.

Key Features

- Occurs on lower slopes and valley bottoms of the Front Ranges south of the Bow Valley, in the Porcupine Hills, within the lower valleys of major mountain river valleys north of the Bow Valley, and on the uppermost elevations of the Cypress Hills.
- Chinooks are frequent along the Front Ranges, and winters are warm with much lower snowfalls than in the Subalpine and Alpine Natural Subregions.
- Highly variable microclimates produced by differing aspects, slope positions and wind exposures produce abrupt changes in vegetation over very short distances.

Overview (Photo: G. Klappstein)

Total area: 8768 km^2 (18% of Rocky Mountain Natural Region).

Average elevation: 1400 m (range 825-1850 m).

Open Limber pine stands and grasslands are typical of Montane valleys. (Photo: L. Allen)

General Description

The Montane Natural Subregion is composed of several separate units. The largest continuous unit spans lower elevations along the Front Ranges of the Rocky Mountains from just north of the Bow Valley to the Alberta–Montana border, including the Porcupine Hills. An outlier occurs on the highest elevations of the Cypress Hills in southeastern Alberta.

North of the Bow River Valley, the Montane Natural Subregion extends from the foothills west into the Main Ranges along major east-west river valleys including the North Saskatchewan, Athabasca and Smoky Rivers, with a small isolated outlier on the Red Deer River at the Ya-Ha-Tinda Ranch. Its upper boundary is the lower limit of the Subalpine Natural Subregion.

South of the Bow River, the Montane Natural Subregion intergrades with the Foothills Fescue and Foothills Parkland Natural Subregions, which have similar climates, vegetation and soils along the boundary. North of the Bow River, the Montane Natural Subregion is bounded on the east by the Upper Foothills or Lower Foothills Natural Subregions.

This is the driest and warmest of the three Natural Subregions in the Rocky Mountain Natural Region, and regional and local climatic influences produce a highly diverse array of plant communities and soil types that change rapidly over very short distances.

Climate

Mild summers, a summer-high precipitation pattern, frequent Chinook winds and warm winters are characteristics of the Montane Natural Subregion (see Table 3-2 in Part 3 for annual and seasonal climatic statistics). Owing to warm Pacific air masses and frequent Chinooks, winters in the Montane Natural Subregion are warmer than anywhere else in Alberta except the Foothills Fescue and Foothills Parkland Natural Subregions.

Pronounced differences in microclimate occur because of variable terrain. North- and east-facing slopes tend to be cooler and moister because they receive less direct sun and are generally protected from the prevailing westerly winds. In contrast, south- and west-facing slopes receive both higher insolation and the drying influences of westerly winds. There may also be significant moisture deficits on these sites. Particularly well-defined vegetation patterns such as the grassland/forest mosaics of the Whaleback Ridge and the Porcupine Hills reflect the often abrupt nature of topographically controlled moisture and temperature gradients.

Vegetation

Vegetation patterns in the Montane Natural Subregion are complex. Plant community changes occur locally and across the Natural Subregion in response to slope, aspect, elevation and latitude. Plant species distribution patterns, along with significant regional variations in landscapes, suggest a division into three districts defined by topography and latitude:

- southern foothills and plains district,
- southern and central mountain valley district,
- northern mountain valley district.

The southern foothills and plains district includes lower-elevation areas along the Front Ranges, mainly south of the Bow River Corridor. The *Cypress Hills variant*, although geographically separated from the southern foothills by about 300 km, is most similar to this district in terms of flora and climate. However, limber pine and Douglas fir, both characteristic of the south-central mountains, are not found in the Cypress Hills.

The southern and central mountain valley district includes the Crowsnest Pass, Bow Valley and Ya-ha-Tinda area. The northern mountain valley district includes the North Saskatchewan River and mountain valleys to the north (the Athabasca River valley between Jasper and Hinton, and the Smoky River valley near Grande Cache).

The Kootenay Plains lie within the North Saskatchewan River valley and are arbitrarily placed in the northern mountain valley district. They are transitional between the southern and northern valley districts, with grasslands typical of more northerly Montane areas and tree species typical of southern Montane areas, such as limber pine. Figure 4-1.4 shows the general sequence of ecosystems arranged along a moisture and nutrient gradient.

Vegetation of the southern foothills and plains district and southern and central mountain valley district

Exposed, rocky ridgetops and upper slopes in the south-central foothills and plains district are vegetated by open limber pine and Douglas fir stands, with an understory of ground juniper, bearberry and mountain rough fescue. Rapidly drained Chernozems are typical, and Brunisols also occur.

At lower elevations on dry sites in the southern foothills, grasslands dominated by bluebunch wheatgrass, mountain rough fescue and sedge are typical; many of these grassland species gradually decline in abundance to the north. The grasslands and open forests of the Kootenay Plains (North Saskatchewan River valley) are the approximate south–north dividing line between the southern and central mountain valley and the northern mountain valley districts.

The grasslands in the Kootenay Plains are dominated by northern wheatgrass and June grass. The bluebunch wheatgrass and mountain rough fescue communities that are more typical of the southern Montane Natural Subregion are both absent. The open forests include Douglas fir and limber pine, the latter species reaching its northern limits in North America in the Kootenay Plains.

In the southern foothills and plains district, and in the southern and central mountain valley districts at lower elevations, moderately dry south- and west-facing slopes may be vegetated by open forests or grasslands. Open forests typically include lodgepole pine, Douglas fir, aspen, and white spruce as pure or mixed stands with understories of bearberry, Canada buffaloberry, hairy wild rye, pine reed grass and forbs on well drained, medium to fine textured Luvisolic and Brunisolic soils. Grasslands are also common on moderately dry south- and west-facing aspects and include mountain rough fescue, bluebunch fescue and Parry oatgrass on well to moderately well drained Chernozemic soils.

Moister sites in the southern foothills and plains district and in the southern and central mountain valley district support Douglas fir, aspen, lodgepole pine and white spruce stands with diverse understories. At higher elevations, young lodgepole pine stands are dominant; mixedwood and Douglas fir forests are secondary components except in the Porcupine Hills. White spruce and Engelmann spruce hybridize, and subalpine fir is occasional.

Green alder, white meadowsweet, a variety of forbs and feathermosses are typical understory species. Soils are generally medium to fine textured Brunisols and Luvisols, with some Chernozems occurring at the lowest elevations.

South of the Crowsnest Pass, species such as creeping mahonia, mountain lover and beargrass are locally common. Moist sites have diverse and vigorous shrub and forb understories with nutrient indicators such as thimbleberry, red-osier dogwood, baneberry, and cow parsnip. Balsam poplar may occur along with other tree species in the overstory.

Thimbleberry is common understory species on moist nutrient- rich sites (Photo: L. Allen)

Fine textured, moderately well to imperfectly drained Brunisols, Luvisols and Chernozems are associated with these sites. The wettest sites are willow- or sedge-dominated fens with high water tables and poorly drained Gleysolic soils. Treed fens are very uncommon, and occupy the wettest sites on poorly drained Organic and Gleysolic soils. White spruce is the dominant species, and black spruce is rarely found on highly calcareous sites or in wetlands south of the Bow River corridor.

Plant communities in the Cypress Hills variant are floristically similar to the southern foothills and plains district to the west. Because of silty or occasionally gravely, well drained soils and possibly grazing history, grassland communities on level hilltop locations typically have a higher proportion of shrubby cinquefoil and western porcupine grass than communities to the west, and Black Chernozemic soils are common.

Douglas fir, limber pine and bluebunch wheatgrass are common in the foothills, but are not found in the Cypress Hills. Forests in the Cypress Hills occur on northerly slopes with Luvisolic soils, and include pure or mixed lodgepole pine, aspen and white spruce stands with understories of white meadowsweet, forbs, pine reed grass and white-grained mountain ricegrass.

Vegetation of the northern mountain valley district

In the northern mountain valley district, hairy wild rye replaces pine reed grass on moist to moderately dry sites, and June grass replaces mountain rough fescue on dry exposed sites. Grasslands are less extensive in this district than in the southern and central mountain valley district. Douglas fir is less common, occurring only within Jasper National Park where it reaches its northernmost known limit in Alberta, and lodgepole pine, aspen and white spruce form the main canopy on forested sites. Black spruce is restricted to wet non-calcareous sites.

The driest, most exposed sites in the northern mountain valleys are vegetated by shrubby grasslands with bearberry, silverberry, juniper, Canada buffaloberry, pasture sagewort, hairy wild rye and June grass, and rapidly drained Brunisols are typical. Limber pine and Douglas fir occur on exposed locations in the Kootenay Plains. Somewhat moister sites are forested by open lodgepole pine or white spruce stands with understories of bearberry, Canada buffaloberry and hairy wild rye on well drained Brunisolic soils.

Typical sites in the northern mountain valley district are forested, occurring on variable slopes and aspects, usually with well drained, moderately moist and often calcareous Brunisolic soils. Mixed lodgepole pine, aspen or white spruce stands have an understory of hairy wild rye and other herbaceous species. Feather moss mats are typical of closed-canopy lodgepole pine and white spruce stands.

Nutrient-rich, moist sites are typically forested by mixed aspen–balsam poplar stands with a lush understory of red-osier dogwood, rose, willow and herbs on moderately well to imperfectly drained, fine textured Brunisolic and Gleyed Gray Luvisols. Shrub and herb-dominated meadows also occur on rich sites along streams.

Wetter forested sites are occupied by white spruce stands with horsetail and willow understories on imperfectly to poorly drained Gleysolic and Regosolic soils. Treed, shrubby and sedge-dominated fens are uncommon, and occupy the wettest sites on poorly drained Organic and Gleysolic soils. White spruce is more common than black spruce in treed fens, especially in highly calcareous areas such as those found near Hinton in the Athabasca River valley.

Plant community summaries are presented in Archibald et al. (1996) and Beckingham et al. (1996) for the three districts described above, respectively. Willoughby et al. (2003) also define numerous shrub and grassland communities for these areas.

Geology and Geomorphology

The Montane Natural Subregion includes the rolling and hilly foothills of southwestern Alberta and outliers on the Porcupine Hills and Cypress Hills as well as the valley floors and lower slopes of the Crowsnest, Bow, North Saskatchewan, Athabasca and Smoky Rivers that flow from west to east through the Front Ranges.

Sandstone outcrops in the Porcupine Hills. (Photo L. Allen)

The foothills area is composed of non-marine Cretaceous sandstones, siltstones and shales (Alberta Group, Belly River, St. Mary's River). The Porcupine and Cypress Hills are underlain by non-marine Tertiary sandstones and siltstones. Glacial and river erosion has carved major valleys through Mesozoic and Paleozoic dolomitic and limestone formations and Cretaceous sediments. Rock strata are generally oriented perpendicular to water flow.

Surficial materials in the foothills are mainly medium textured, weakly calcareous tills. However, these deposits can be quite thin in steeper areas where textures tend to be more variable. In major river valleys, fluvial and glaciofluvial sands and gravels form level to gently undulating terraces on valley bottoms; till and colluvial deposits of variable textures occur on lower slopes. Bedrock exposures occur both in the foothills and in the valleys. Extremely calcareous loessal materials occur at the eastern extension of the Athabasca valley in the Brule Lake area.

Appendix 4 summarizes the proportional occurrence of landscape elements and parent materials in the Montane Natural Subregion.

Water and Wetlands

About 3 percent of the total area in the Montane Natural Subregion is occupied by water; major rivers and five standing water bodies (Waterton, Minnewanka, Abraham and Brule Lakes and the Ghost Reservoir) account for most of this area. Wetlands are rare in this Natural Subregion, but rich, often calcareous fens and marshes do occupy about 2 percent of the total Subregion area.

Soils

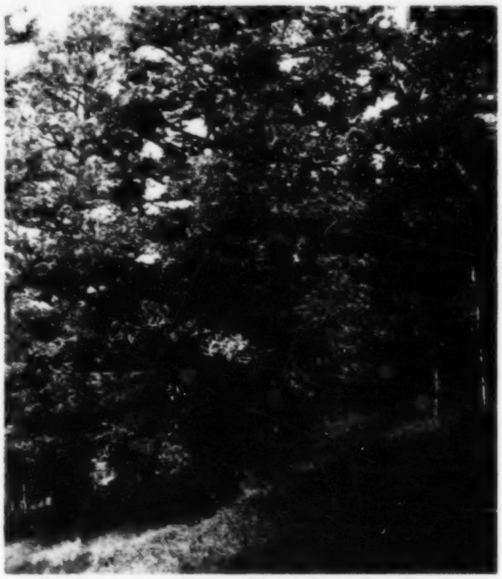
In the foothill and outlying Montane areas of southern and southwestern Alberta, Orthic Black Chernozems are typical under grasslands with Orthic Dark Gray Chernozems becoming dominant in the wooded areas. On moister northern slopes and higher elevations, Gray Luvisols become significant. Bedrock exposures (nonsoils) also occur.

In the valleys, Eutric Brunisols are the dominant soil on fluvial and glaciofluvial deposits. Regosols are typical of both fluvial terraces adjacent to the rivers and side slopes where erosion or slope movement has recently occurred. Valley side soils may also include Luvisols and Dystric Brunisols where slopes are stable enough to allow soil development to occur. Gleysols and Organic soils are typically associated with fens. Appendix 5 summarizes the proportional occurrence of soil types in the Montane Natural Subregion.

Land Uses

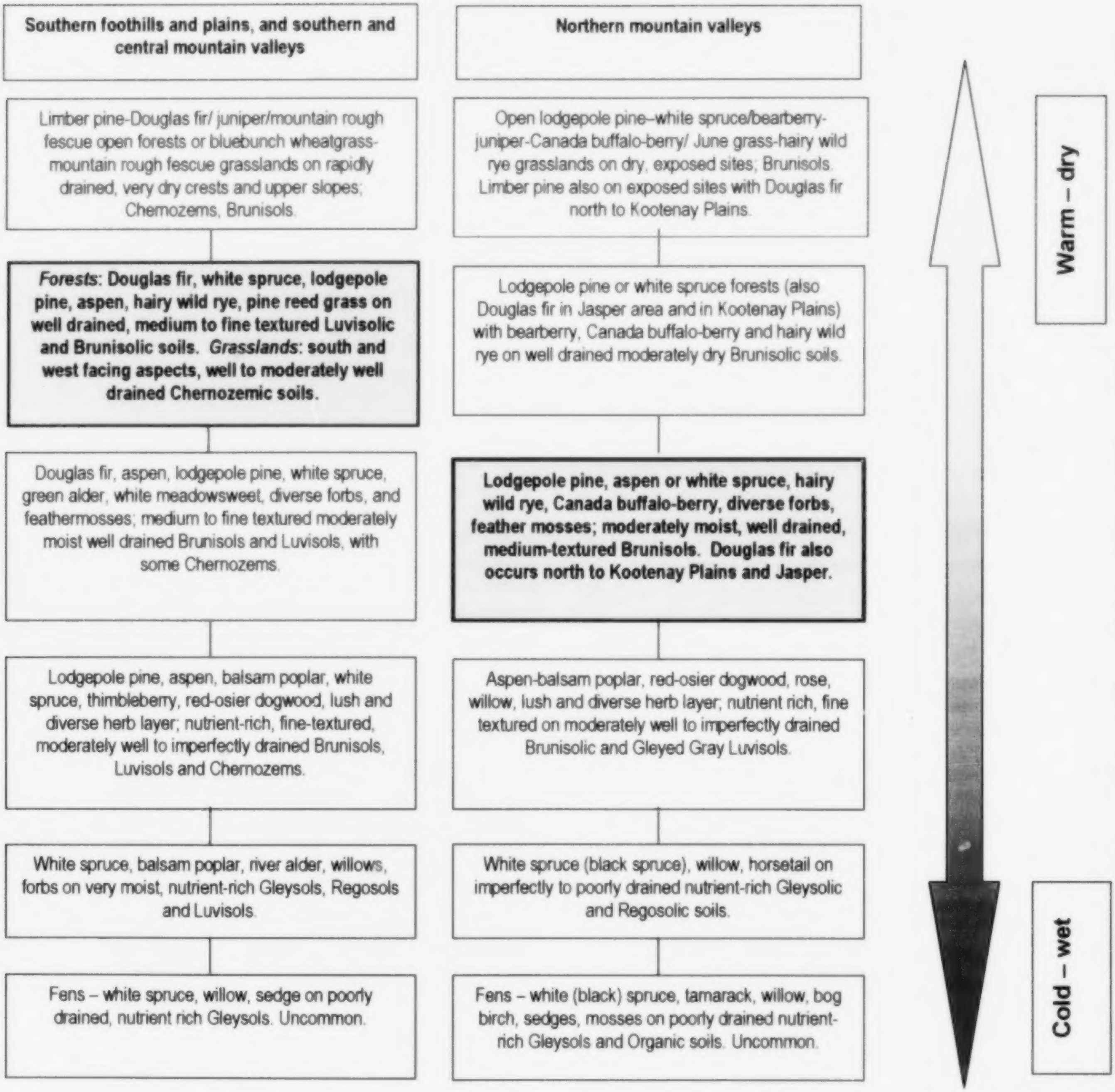
The Montane Natural Subregion provides important wildlife habitat, and is highly valued for recreational activities and domestic grazing. Because of its favorable location near or in the mountains and the mild climate, this Natural Subregion is considered a desirable place to live, and urban development is occurring at a rapid pace in some areas.

Timber harvesting is locally important and standing volumes can be high, especially in the mature Douglas fir forests of southern Alberta. Regeneration is challenging, however, because of potentially droughty conditions and calcareous soils. Mining is a locally important activity in the Bow Corridor. Ranching occurs throughout the Natural Subregion. Three main transportation corridors (the Yellowhead, Trans-Canada and Crowsnest highways) occupy valley bottoms in the Montane Natural Subregion.



Mixed stands dominated by Douglas fir are a common south-central Montane ecosystem.

(Photo G. Klappstein)



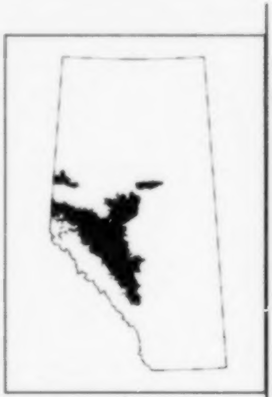
Southern foothills and plains, and southern and central mountain valleys	Northern mountain valleys
Limber pine-Douglas fir/ juniper/mountain rough fescue open forests or bluebunch wheatgrass-mountain rough fescue grasslands on rapidly drained, very dry crests and upper slopes; Chernozems, Brunisols.	Open lodgepole pine–white spruce/bearberry-juniper-Canada buffalo-berry/ June grass-hairy wild rye grasslands on dry, exposed sites; Brunisols. Limber pine also on exposed sites with Douglas fir north to Kootenay Plains.
***Forests*: Douglas fir, white spruce, lodgepole pine, aspen, hairy wild rye, pine reed grass on well drained, medium to fine textured Luvisolic and Brunisolic soils. *Grasslands*: south and west facing aspects, well to moderately well drained Chernozemic soils.**	Lodgepole pine or white spruce forests (also Douglas fir in Jasper area and in Kootenay Plains) with bearberry, Canada buffalo-berry and hairy wild rye on well drained moderately dry Brunisolic soils.
Douglas fir, aspen, lodgepole pine, white spruce, green alder, white meadowsweet, diverse forbs, and feathermosses; medium to fine textured moderately moist well drained Brunisols and Luvisols, with some Chernozems.	**Lodgepole pine, aspen or white spruce, hairy wild rye, Canada buffalo-berry, diverse forbs, feather mosses; moderately moist, well drained, medium-textured Brunisols. Douglas fir also occurs north to Kootenay Plains and Jasper.**
Lodgepole pine, aspen, balsam poplar, white spruce, thimbleberry, red-osier dogwood, lush and diverse herb layer; nutrient-rich, fine-textured, moderately well to imperfectly drained Brunisols, Luvisols and Chernozems.	Aspen-balsam poplar, red-osier dogwood, rose, willow, lush and diverse herb layer; nutrient rich, fine textured on moderately well to imperfectly drained Brunisolic and Gleyed Gray Luvisols.
White spruce, balsam poplar, river alder, willows, forbs on very moist, nutrient-rich Gleysols, Regosols and Luvisols.	White spruce (black spruce), willow, horsetail on imperfectly to poorly drained nutrient-rich Gleysolic and Regosolic soils.
Fens – white spruce, willow, sedge on poorly drained, nutrient rich Gleysols. Uncommon.	Fens – white (black) spruce, tamarack, willow, bog birch, sedges, mosses on poorly drained nutrient-rich Gleysols and Organic soils. Uncommon.

Figure 1. Figure 4-1.4. Common ecosystems arranged along environmental gradient, Montane Natureal Subregion. (*Reference sites are in blue-shaded boxes in boldface type.*)

4.2 FOOTHILLS NATURAL REGION

Theme

The Foothills Natural Region is influenced by a moist, cool climate. Gently undulating to rolling till-covered hills and plateaus with deciduous and mixedwood forests are typical of lower elevations, and strongly rolling to steeply sloping hills with coniferous forests are prevalent at higher elevations.



Total area: 66,436 km^2 (10% of province)

Species such as wapiti range between the Rocky Mountains and the Foothills Natural Regions. (Photo: K. Crockett)

General Description

The Foothills Natural Region includes the Lower and Upper Foothills Natural Subregions. The Region extends along the eastern flank of the Rocky Mountains north from the Bow River Valley to just south of Grande Prairie. It also includes the Swan Hills and Pelican Mountain outliers to the east and the Saddle Hills outlier north of Grande Prairie.

The topography is highly variable, ranging from sharp, bedrock-controlled ridges near the mountains to rolling and undulating terrain in the north and east. Elevations within the Foothills Natural Region range from a low of 700 m in the most northerly areas to a maximum of about 1700 m in the south.

Mixed forests of aspen, lodgepole pine, white spruce and balsam poplar with variable understories on Gray Luvisolic soils are dominant on average sites at lower elevations. Lodgepole pine forests with less diverse understories and well developed feathermoss layers on Brunisolic Gray Luvisols are typical of higher elevations.

Climate

Distinctive vegetation and soils patterns reflect subregional climate changes and characterize the Lower Foothills and Upper Foothills Natural Subregions. Figure 4-2 presents the major climatic characteristics of both Natural Subregions. Both receive relatively high annual precipitation, and only the Alpine and Subalpine Natural Subregions are wetter. Average July precipitation is higher in the Lower and Upper Foothills Natural Subregions than in any others.

The Lower Foothills Natural Subregion has somewhat warmer summers and colder winters than the Upper Foothills Natural Subregion. The growing season is longer and total precipitation is lower especially in the winter months, indicating a stronger continental climate influence. Higher elevations and proximity to the mountains produce cooler summers, warmer winters and more precipitation than is characteristic of the adjacent Central Mixedwood Natural Subregion to the north and east.

Vegetation

Forests are the dominant vegetation cover in both Natural Subregions, and lodgepole pine stands are considered a good indicator of the Foothills Natural Region–Boreal Forest Natural Region boundary. Forests on upland sites within the Lower Foothills Natural Subregion are typically deciduous or mixedwood with aspen, balsam poplar, white birch, lodgepole pine, white spruce and black spruce as common associates. Wetlands are mainly vegetated by stunted black spruce and tamarack or shrub-graminoid communities.

The boundary between the Lower and Upper Foothills Natural Subregions is reasonably well defined by a change in dominance from mixedwood and deciduous stands on all aspects in the Lower Foothills Natural Subregion to conifer-dominated forests in the Upper Foothills Natural Subregion.

Topography, Geology, Soils and Hydrology

Sandstone and mudstone bedrock strata that are generally overlain by medium textured, weakly calcareous glacial till define both the geology and topography of the Foothills Natural Region. Fluvial deposits occur along stream systems; colluvial and residual deposits are associated with steep slopes and exposed bedrock.

Upland soils at lower elevations are mainly Orthic Gray Luvisols. Mixing of organic materials and humus formation in the litter layer and upper mineral soil horizons is limited by cool temperatures that reduce microbial and invertebrate activity. Brunisolic Gray Luvisols with thin, acidic litter layers occur at higher elevations in response to increased moisture and coniferous forest cover. Seepage is common in lower slope positions. Gleysols and Organic (mainly Mesisolic) soils are associated with wet conditions along lower slopes and in valley bottoms.

Water bodies occupy less than 1 percent of the total area within the Foothills Natural Region, and include the Athabasca and North Saskatchewan Rivers. Wetlands occur throughout the Natural Region, and are less common in the steep-sided valley systems typical of the Upper Foothills than in the gentler terrain of the Lower Foothills.

Appendices 4 and 5 summarize the proportional occurrence of landscape elements, parent materials and soil types in the Foothills Natural Region.

Wildlife Habitats and Populations

The Foothills Region exhibits high habitat diversity because of variable topography, surface and groundwater flow regimes, and correspondingly variable plant communities. Many of the vertebrate species occurring in this Region are wide ranging and are also present in the neighboring Boreal and Rocky Mountain Natural Regions. While there are no vertebrate species with a distribution limited to the Foothills Natural Region, its transitional position between the Rocky Mountain and Boreal Forest Natural Regions contributes to a relatively high diversity of animal species. Species such as wapiti (also called elk) range between the Rocky Mountains and the Foothills Natural Regions.

Wide-ranging species that can be found from the Rocky Mountains, through the Foothills and into the Boreal include the Boreal Chickadee, Spruce Grouse, Ruby-crowned Kinglet, American Robin, White-winged Crossbill, Dark-eyed Junco, Yellow-rumped Warbler, red squirrel, varying hare, deer mouse, southern red-backed vole and black bear.

Highly diverse wildlife communities occur in association with rich, moist deciduous forests, mainly in the eastern and southern parts of the Lower Foothills Natural Subregion. Common species in such areas include Ruffed Grouse, Warbling Vireo, Black-capped Chickadee and Tennessee Warbler. Localized areas of lush deciduous growth are of special significance for songbird and mammal diversity. These areas are usually located in sloping or valley bottom areas receiving higher precipitation and/or nutrient-rich groundwater discharge. Slumping on unstable slopes further contributes to habitat diversity.

The Foothills Natural Region–Boreal Forest Natural Region climatic transition is marked by a similar transition in the abundance and composition of wildlife species. Along the eastern boundary of the Foothills Natural Region, species more typical of the Boreal Forest Natural Region occur, including the Yellow-bellied Sapsucker, Rose-breasted Grosbeak and Purple Finch. Varied Thrush, a species more common in mountain habitats, has been recorded during nesting season in high-elevation, wet spruce–fir forests in the Swan Hills. The occurrence of this species suggests some affinity with the Subalpine Natural Subregion.

Wetlands and lakes provide additional habitat diversity. Of note is the role that beaver populations play in creating habitat for other species including Barrow's Goldeneye and Trumpeter Swan (recognized as a "Threatened" species by the Government of Alberta). These types of habitats are also suitable for long-toed salamander (listed as a "Species of Special Concern" by the Government of Alberta). Inhabitants of wetland habitats include Lesser Yellowlegs, Common Snipe, Lincoln's Sparrow, meadow vole, moose, boreal toad and wood frog.

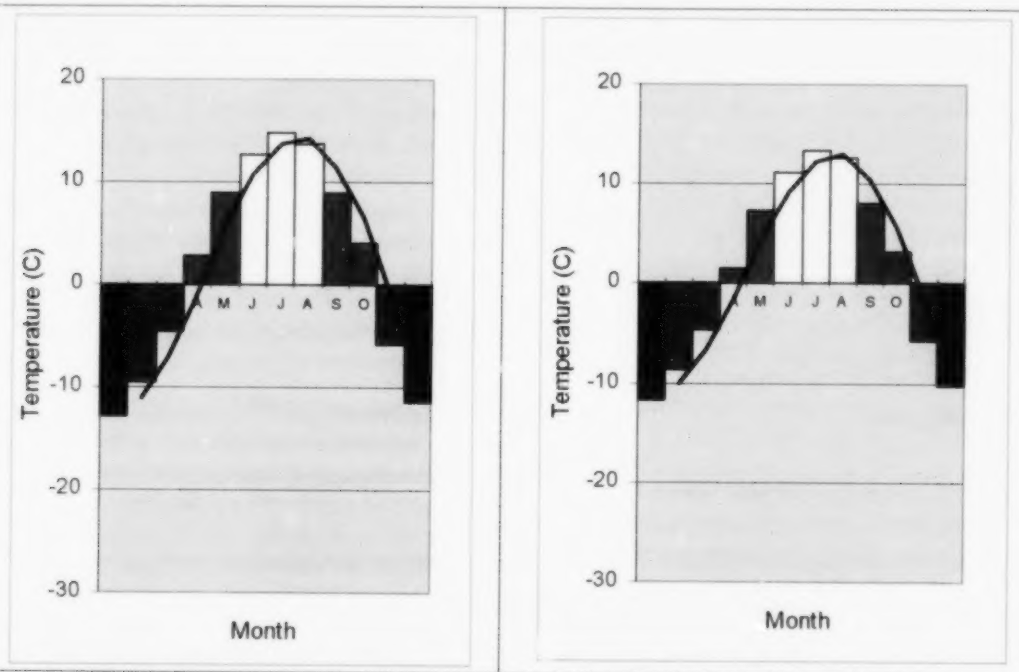
In the south and east portions of the Natural Region, wetland habitats are more diverse and richer in species diversity. Naturally occurring fish species include Rocky Mountain whitefish, bull trout, Arctic grayling, burbot and white sucker.

Notable Features

Several significant wildlife species include the Foothills Natural Region as part of their range. These are as follows:

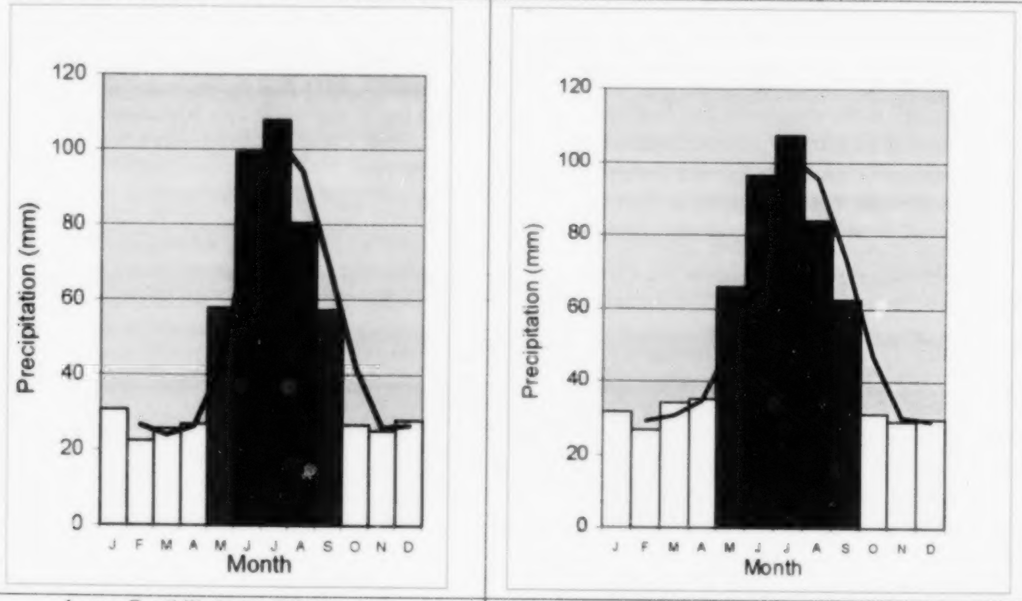
- *Grizzly bear*. This species has been designated as "Species of Special Concern" by COSEWIC. The Foothills Natural Region contains significant areas of suitable grizzly habitat.
- *Woodland caribou* (both mountain and boreal ecotypes). This species is designated as "Threatened" by the Government of Alberta and COSEWIC. Caribou populations in Alberta range from stable to declining. The Foothills Natural Region includes critical habitat for these ungulates.
- *Wolverine*. This species is designated as a "Species of Special Concern" by COSEWIC. The Foothills Natural Region provides habitat for these animals.
- *Flora*. About 80 rare vascular plant species occur in the Foothills Natural Region, but most of these are also found in the adjacent Rocky Mountain and Foothills Natural Regions (Kershaw et al. 2001).

The Foothills Natural Region contains significant areas of suitable grizzly habitat. (Photo: Alberta Sustainable Resource Development)



Lower Foothills Natural Subregion
Mean Monthly Temperature
(MAT +1/8°C)

Upper Foothills Natural Subregion
Mean Monthly Temperature
(MAT +1.3°C)



Lower Foothills Natural Subregion
Mean Monthly Precipitation
(MAP 632 mm)

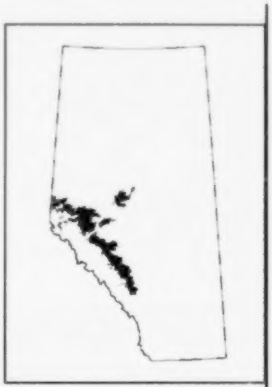
Upper Foothills Natural Subregion
Mean Monthly Precipitation
(MAP 588 mm)

Figure 4-2.1. Foothills Natural Region climate data summaries. (*Refer to footnotes in Figures 3-8 and 3-11 for color scheme explanations. MAP = Mean Annual Precipitation, MAT = Mean Annual Temperature.*)

4.2.1 Upper Foothills Natural Subregion

Theme

Short, wet summers and snowy, cold winters influence the Upper Foothills Natural Subregion. Closed-canopy conifer stands of lodgepole pine, black spruce and white spruce on rolling to steeply sloping terrain are typical.



Overview (Photo: A. Landals)

Total area: 21.537 km2 (32% of Foothills Natural Region).
Average elevation: 1300 m (950-1750 m).

Key Features

- Lodgepole pine is usually dominant in pure stands on mesic sites, with white spruce and white-spruce-Engelmann spruce hybrids at higher elevations along the boundary with the Subalpine Natural Subregion.
- Subalpine indicators are restricted to northerly aspects at the highest elevations (e.g., white-flowered rhododendron).
- Pure deciduous stands are generally restricted to southerly aspects, and mixed conifer–deciduous stands are much less common in the Upper than in the Lower Foothills.

Labrador tea is a common understory species. (Photo: L. Allen)

General Description

The Upper Foothills Natural Subregion includes about 34 percent of the Foothills Natural Region area. It occupies a narrow belt between the Lower Foothills Natural Subregion at lower elevations and the Subalpine Natural Subregion at higher elevations, with one outlier on the highest elevations of the Swan Hills.

Elevations range from about 1050 m in the north to more than 1700 m in the south and west along its boundary with the Subalpine Natural Subregion. Its lower boundary with the Lower Foothills Natural Subregion decreases with latitude at a rate of about 1.2 m per kilometer northward. Its upper boundary with the Subalpine Natural Subregion decreases at a rate of about 0.6 m per kilometer northward.

Upper Foothills Natural Subregion climate, soils and vegetation patterns indicate a transition between the drier, somewhat warmer conditions of the Lower Foothills Natural

Subregion and the cooler, wetter conditions of the Subalpine Natural Subregion. The Upper Foothills Natural Subregion occurs mainly within the high-elevation dissected plateaus and foothills of the Rockies Front Ranges. Strongly rolling to steep terrain with thin glacial deposits and exposed bedrock is typical.

Climate

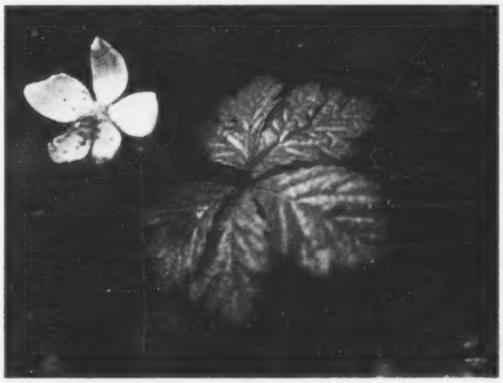
Monthly temperature and precipitation patterns are shown above in Figure 4-2.1 and Table 3-2 (in Part 3) summarizes annual and seasonal climate statistics. Compared to the Lower Foothills Natural Subregion, the Upper Foothills Natural Subregion is on average cooler year-round with cooler summers and slightly warmer winters, has a shorter growing season, and receives heavier summer and winter precipitation. It has the highest July precipitation of any Natural Subregion.

These conditions favour the growth of conifers over deciduous species because evergreen needles can begin photosynthesis early in the spring and continue late into the fall, and because the growing season may not be long enough to allow the maturation of twigs and buds on deciduous trees. Pure deciduous stands are usually restricted to the warmer microclimates created by south and west-facing aspects that lose their snowpack and remain warmer later into the fall.

Tall bilberry is a common understory species. (Photo: L. Allen)

Vegetation

Forests dominate the Upper Foothills Natural Subregion, and are typically even-aged fire-origin lodgepole pine stands, often with an understory of black spruce. White spruce stands occur along river valleys and on lower slopes. Deciduous and mixedwood stands are restricted to southerly and westerly slopes where conditions are similar to those found at lower elevations. Shrubby grasslands occur on the driest sites, and poor to rich fens dominated by black spruce, tamarack, shrubs and herbs occur on low, wet sites.



Dwarf bramble marks the change from the Lower to Upper Foothills in the northern part of the region. (Photo: L. Allen)

The lower boundary of the Upper Foothills Natural Subregion is marked in part by the transition from mixedwood-dominated forests in the Lower Foothills Natural Subregion to conifer-dominated forests in the Upper Foothills Natural Subregion. Indicator species such as tall bilberry (throughout the Natural Subregion) and dwarf bramble (in the northern half) also mark the change from the Lower to Upper Foothills Natural Subregions.

At the upper limits of the Upper Foothills Natural Subregion, hybridization between white spruce, a low-elevation species, and Engelmann spruce, a subalpine species, becomes more pronounced, as does hybridization between the lowland balsam fir and the higher-elevation subalpine fir. Shrubby subalpine indicator species such as white-flowered rhododendron, false azalea, crowberry and in the south, grouseberry begin to appear at the upper limits of the Upper Foothills Natural Subregion, particularly on northerly aspects.

Plant communities in the Upper Foothills Natural Subregion are less diverse than those on similar sites in the Lower Foothills Natural Subregion, reflecting a shorter, cooler growing season. There is a similar north-south division to that noted for the Lower Foothills Natural Subregion, reflecting the effects of latitude on species distribution and community composition.

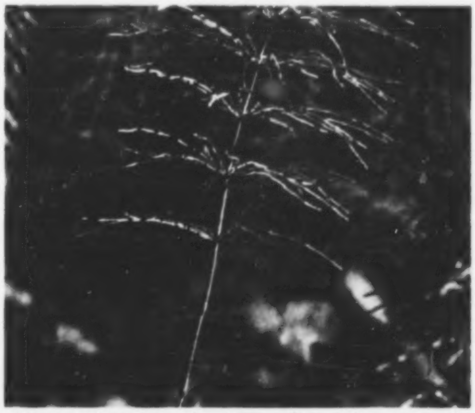
Mesic sites south of the North Saskatchewan River are dominated by lodgepole pine–white spruce mixtures. Black spruce is seldom found in the understory, and common Labrador tea is present but with low cover. Mesic sites north of the North Saskatchewan River include mixed stands of aspen, lodgepole pine and white spruce. Black spruce occurs with low cover, and common Labrador tea is present with higher cover than in the southern areas.

Figure 4-2.2 shows the general sequence of communities commonly associated with dry to wet sites in the Upper Foothills Natural Subregion. On the driest sites, bearberry, common juniper and hairy wild rye form open communities. Slightly moister sites typically support pure or mixed aspen, lodgepole pine and white spruce stands with an understory of bearberry and hairy wild rye.

Bracted honeysuckle is common in rich, moist sites. (Photo: D. Vujnovic)

Rich, moist sites have the highest species diversity and vigor, with bracted honeysuckle, ferns, cow parsnip and bluejoint as common associates under mixed or pure overstories of aspen, balsam poplar, lodgepole pine and white spruce.

Nutrient-poor mesic to very moist sites have an overstory of lodgepole pine and black spruce, the latter dominant on wetter areas, and a species-poor understory dominated by feathermosses with variable cover of common Labrador tea, bog cranberry, and common blueberry.



Horsetails often dominate the understory of moist stands. (Photo: L. Allen)

Wet areas support a diverse array of communities depending on nutrient conditions. Black and white spruce occur in pure or mixed stands often with tamarack. Horsetails, common Labrador tea, willows, bog birch and various mosses occur in the understory. Shrubby or sedge-dominated fens occur in the wettest locales.

Beckingham et al. (1996), Archibald et al. (1996) and Willoughby (2005) provide a more detailed account of plant communities and site types in the Upper Foothills Natural Subregion.

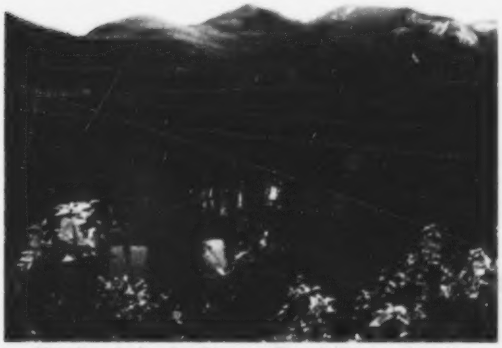
Geology and Geomorphology

The Upper Foothills Natural Subregion is characterized by very hilly terrain associated with the foothills and high-elevation dissected plateaus of west-central Alberta. The bedrock is composed mainly of sandstones and mudstones of Tertiary and Upper Cretaceous origin; coal seams are common in the latter.

Surficial materials are usually glacial till veneers and blankets over bedrock, with some colluvium and exposed bedrock on the steeper slopes. The till is variable in texture and chemistry, but is mainly medium textured and weakly calcareous. Appendix 4 summarizes the proportional occurrence of landscape elements and parent materials in the Upper Foothills Natural Subregion.

Water and Wetlands

There is very little standing water in this strongly dissected landscape, although many major rivers (including the North Saskatchewan, Macleod, Athabasca, Smoky and Wapiti) run eastward and northward through the Upper Foothills Natural Subregion.



Wetlands in the Upper Foothills tend to be confined to the valleys. (Photo: D. Vujnovic)

Wetlands occur over about 10 percent of the Upper Foothills Natural Subregion, and are confined to the major valleys. Where organic accumulations occur, they are typically thin and often gently sloping. Treed and shrubby fens occurring on organic deposits are slightly more common than those occurring on wet Gleysolic mineral soils. Seepage is common on lower slopes.

Soils

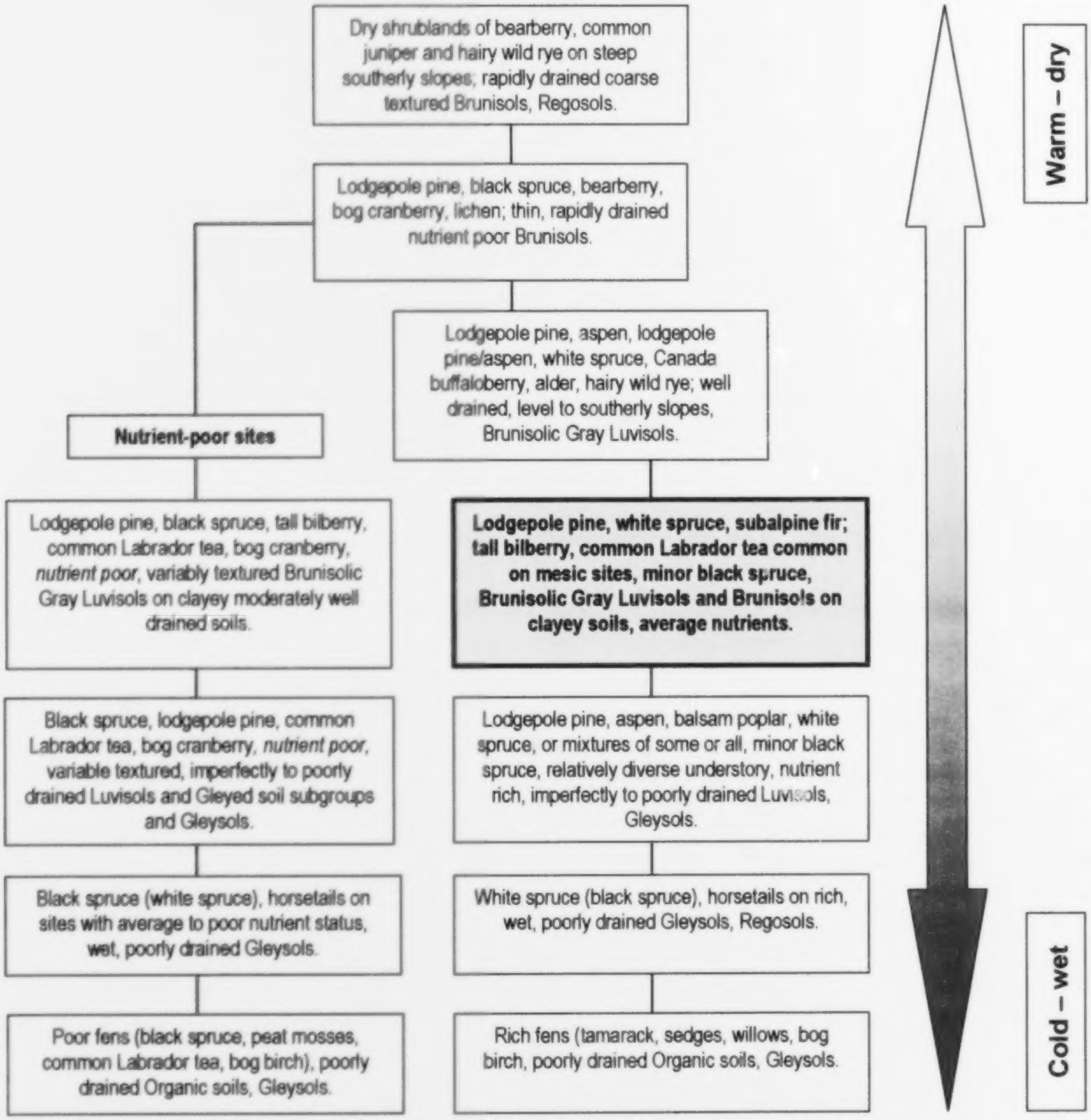
Well to imperfectly drained Brunisolic Gray Luvisolic soils are typical throughout most of the area. Orthic Gray Luvisols are associated with moderately well drained sites, and are usually associated with stands having a deciduous component. Brunisols are typical of less stable colluvial and weathered residual materials. Wetlands are a complex of Terric and Typic Mesisols along with Peaty and Orthic Gleysols. Appendix 5 summarizes the proportional occurrence of soil types in the Upper Foothills Natural Subregion.

Land Uses

The Upper Foothills Natural Subregion includes large areas of productive timber, but is somewhat less productive than the Lower Foothills Natural Subregion owing to its shorter growing season which precludes till cropping and most tame forage production. Grazing occurs on native rangelands, on disturbed areas that have been reclaimed, and on recently harvested forest stands.

Coal seams underlie much of the area; where these seams are close enough to the surface, open-pit mines have been developed. These coal seams are also a potential source of coalbed methane which is a rapidly expanding resource development activity in Alberta. Intensive oil and gas exploration and development has occurred over the last several decades, and the resulting network of seismic lines has created access throughout the Natural Subregion for recreational users.

Even-aged fire-origin lodgepole pine stands with a common Labrador tea understory are typical of the Upper Foothills. (Photo: H. Archibald)



Dry shrublands of bearberry, common juniper and hairy wild rye on steep southerly slopes; rapidly drained coarse textured Brunisols, Regosols.

Lodgepole pine, black spruce, bearberry, bog cranberry, lichen; thin, rapidly drained nutrient poor Brunisols.

Lodgepole pine, aspen, lodgepole pine/aspen, white spruce, Canada buffaloberry, alder, hairy wild rye; well drained, level to southerly slopes, Brunisolic Gray Luvisols.

Lodgepole pine, black spruce, tall bilberry, common Labrador tea, bog cranberry, *nutrient poor*, variably textured Brunisolic Gray Luvisols on clayey moderately well drained soils.

Lodgepole pine, white spruce, subalpine fir; tall bilberry, common Labrador tea common on mesic sites, minor black spruce, Brunisolic Gray Luvisols and Brunisols on clayey soils, average nutrients.

Black spruce, lodgepole pine, common Labrador tea, bog cranberry, *nutrient poor*, variable textured, imperfectly to poorly drained Luvisols and Gleyed soil subgroups and Gleysols.

Lodgepole pine, aspen, balsam poplar, white spruce, or mixtures of some or all, minor black spruce, relatively diverse understory, nutrient rich, imperfectly to poorly drained Luvisols, Gleysols.

Black spruce (white spruce), horsetails on sites with average to poor nutrient status, wet, poorly drained Gleysols.

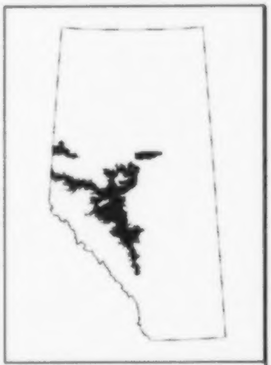
White spruce (black spruce), horsetails on rich, wet, poorly drained Gleysols, Regosols.

Poor fens (black spruce, peat mosses, common Labrador tea, bog birch), poorly drained Organic soils, Gleysols.

Rich fens (tamarack, sedges, willows, bog birch, poorly drained Organic soils, Gleysols.

Figure 4-2.2. Common ecosystems arranged along environmental gradient, Upper Foothills Natural Subregion. (*Reference sites are in blue-shaded boxes in boldface type.*)

4.2.2 Lower Foothills Natural Subregion



Theme

The Lower Foothills Natural Subregion represents a climatic transition area, with cold winters typical of Boreal climates and higher winter snowfalls typical of Cordilleran climates. The rolling, till-covered plateaus are forested by mesic, closed canopy mixed stands of aspen, lodgepole pine, white spruce and balsam poplar.

Overview (Photo: B. Richardson)

Total area: 44,899 km² (68% of Foothills Natural Region).

Average elevation: 950 m (650-1625 m).

Key Features

- Lodgepole pine occurs in pure or mixed stands on mesic sites, differentiating this Natural Subregion from the Boreal Forest Natural Region to the east and north.
- The occurrence of pure deciduous stands on all aspects distinguishes this Natural Subregion from the Upper Foothills Natural Subregion, where pure deciduous stands are typically restricted to southerly aspects.

Low bush cranberry is a common understory species.
(Photo: L. Allen)

General Description

The Lower Foothills Natural Subregion occupies a broad northwest-to-southeast belt between the Bow River Valley to the south and Grande Prairie to the north, with outliers in the Swan Hills and Pelican Mountains to the east, and the Saddle Hills to the north.

It occurs at lower elevations in the Region, ranging from about 700-800 m in the north and east along its boundary with the Dry and Central Mixedwood Natural Subregions, to over 1500 m in the south and west along its boundary with the Upper Foothills Natural Subregion. Its upper boundary with the Upper Foothills Natural Subregion decreases with latitude at a rate of about 1.2 m per kilometer northward; its lower boundary with the Central and Dry Mixedwood Natural Subregions decreases with latitude at a rate of about 1 m per kilometer northward.

Lower Foothills climate, soils and vegetation patterns indicate a transition between cold, dry continental climates and milder, moister Cordilleran climates. Continental influences are more pronounced in the Lower Foothills than in the Upper Foothills. This is most clearly reflected by a decrease in both annual and winter precipitation and an increase in growing degree-days. The Lower Foothills Natural Subregion occurs mainly at the westernmost extent of the Interior Plains, and rolling and undulating till-covered landscapes are typical.

Climate

Monthly temperature and precipitation patterns are shown in Figure 4-2.1, and Table 3-2 summarizes annual and seasonal climate statistics. Precipitation is higher than in adjacent Natural Subregions to the east and north. The available moisture is sufficient to support the growth of lodgepole pine as pure stands and as components of mixedwood stands; however, the growing season is shorter with fewer growing degree-days, and its length is more variable. This restricts the suitability of the Natural Subregion for producing agricultural crops, but forest productivity tends to be high compared to other forested Natural Subregions. Excess moisture in low-lying areas combined with nutrient-rich groundwater can support very productive and species-rich forests.

The Lower Foothills Natural Subregion has a longer growing season than the higher elevation Upper Foothills Natural Subregion, but less winter precipitation. At its northern limits, it differs from the Lower Boreal Highlands Natural Subregion by more frequent and pronounced warm, dry westerly flows in winter and less variation between summer and winter temperature.

Vegetation

The Lower Foothills Natural Subregion has the most diverse forests in Alberta in terms of forest types and tree species. Aspen, balsam poplar, white birch, lodgepole pine, black spruce, white spruce, balsam fir and tamarack grow as pure stands or as mixtures on a variety of slopes and aspects; stands with three or four tree species are common. Pure deciduous stands are more common at lower elevations. Shrubby grasslands occur on the driest sites, and poor to rich fens dominated by black spruce, tamarack, shrubs and herbs occur on low, wet sites.

Tamarack fen. (Photo: L. Allen)

The lower boundary of the Lower Foothills Natural Subregion is marked by the occurrence of lodgepole pine stands on sites of average moisture and nutrient status. Lodgepole pine–jack pine hybrids are found in the Central Mixedwood Natural Subregion near the Central Mixedwood–Lower Foothills boundary, and indicate the combined climatic influences of both Subregions. However, they occur generally as single trees or small clumps of trees distributed within predominantly deciduous stands. The upper boundary of the Lower Foothills Natural Subregion is typically identified by the restriction of pure deciduous stands to mainly southerly and westerly aspects.

The diverse array of sites created by changes in latitude, elevation, aspect and parent material creates a correspondingly high diversity in both community types and species composition. In terms of latitudinal variation, the community types presented in two site guides (Beckingham et al. 1996; Archibald et al. 1996) indicate a north-south division within the Lower Foothills Natural Subregion.

North of the North Saskatchewan River, mesic forest stands have a greater abundance of black spruce and common Labrador tea. Figure 4.2-3 shows the general sequence of communities commonly associated with dry to wet sites in the Lower Foothills Natural Subregion. The left side of the figure shows the sequence of plant communities associated with nutrient-poor conditions; the right side indicates the typical sequence associated with average to rich sites.

On the driest sites, bearberry, common juniper and hairy wild rye form open communities. Slightly moister sites typically support pure or mixed aspen, lodgepole pine and white spruce stands with an understory of bearberry and hairy wild rye.

Bearberry is a common species of dry sites. (Photo: L. Allen)

Mesic sites also support pure or mixed stands of these tree species, but are more species rich. The major species include green alder, low-bush cranberry, prickly rose, wild sarsaparilla, dewberry, fireweed and bluejoint. Nutrient-poor mesic to very moist sites have an overstory of lodgepole pine and black spruce (the latter dominant on wetter areas), and a species-poor understory dominated by feathermosses with variable cover of common Labrador tea, bog cranberry, and common blueberry.

Devil's-club is locally common in west-central Alberta. (Photo: B. Richardson)

Rich, moist sites support diverse, vigorous communities. Bracted honeysuckle, ferns, bluejoint and cow parsnip are common associates under mixed or pure overstories of aspen, balsam poplar, lodgepole pine and white spruce. Devil's-club is locally common in west-central Alberta.

Several different community types occur on wet, poorly drained areas depending on nutrient conditions. Black and white spruce occur in pure or mixed stands, often with tamarack. Horsetail, common Labrador tea, willows, bog birch, and various mosses occur in the understory. Shrubby or sedge-dominated fens occur in the wettest areas. Beckingham et al. (1996), Archibald et al. (1996), and Lane et al. (2000) provide more detailed accounts of plant communities and site types in the Lower Foothills Natural Subregion.

Geology and Geomorphology

Lower Foothills Natural Subregion landscapes are defined by undulating to strongly rolling dissected plateaus at the western edge of the Interior Plains with some inclusions of the undulating Alberta Plains. Sandstones and siltstones of Tertiary origin underlie the southern two thirds of the area, and Upper Cretaceous sandstones and shales underlie the northern portion.

Surficial materials are dominated by medium textured, weakly to moderately calcareous glacial till deposits that are often quite thin on the steeply sloping lands, and may be somewhat stony near the higher elevation plateaus capped with Tertiary gravels. Bedrock exposures can occur in the steep landscapes. There are significant inclusions of glaciofluvial sands and minor amounts of glaciolacustrine clays, mainly in the lower-elevation plains. Appendix 4 summarizes the proportional occurrence of landscape elements and parent materials in the Lower Foothills Natural Subregion.

Water and Wetlands

There is very little standing water in this dissected landscape, with the man-made Brazeau Reservoir being a notable exception. However, many major rivers including the North Saskatchewan, Macleod, Athabasca, Smoky and Wapiti, run eastward and northward through the Lower Foothills Natural Subregion.

Wetlands are not common on the steep valley sides, although seepage is common in places on middle to lower slopes, often on northerly aspects. In the valley bottoms, and particularly on the undulating benchlands and plains, wetlands can cover 15 to 40 percent of the area. Wetlands in this Natural Subregion are characterized by peat accumulations up to 3 m thick. They are dominantly treed fens with some bogs and open fens. Wet mineral soils occasionally occur under the fens.

Soils

Orthic Gray Luvisolic soils dominate on the medium and fine textured materials of the uplands. They are accompanied by Brunisolic subgroups, particularly at higher elevations. Brunisolic Gray Luvisols and Dystric Brunisols are typical of sandy terrain, and Eutric Brunisols and Regosols are often associated with calcareous, recently deposited aeolian and fluvial materials. Most upland soils in these materials are well to imperfectly drained, but there may be imperfectly to poorly drained Gleysolic soils and seepage in lower slope positions.

The wetland organic deposits associated with poor to rich fens are mainly Mesisols, and include an approximately equal representation of Typic and Terric subgroups. Some Fibric Mesisols are associated with relatively uncommon bog vegetation. Orthic and Peaty Gleysols often occur adjacent to wetlands and are more common in the gently undulating areas. Appendix 5 summarizes the proportional occurrence of soil types in the Lower Foothills Natural Subregion.

Land Uses

The Lower Foothills Natural Subregion includes some of the most productive timber areas in Alberta. Till cropping and forage production are mainly restricted to the lower-elevation eastern fringe. Grazing occurs throughout on native rangelands.

Much of the area is underlain by coal seams, and open-pit mines have been developed where these seams are sufficiently close to the surface. Intensive oil and gas exploration and development has occurred over the past several decades; the resulting network of seismic lines has created access throughout the Natural Subregion for recreational users.

Mixed forests of lodgepole pine and aspen ae typical in the Lower Foothills. (Photo: L. Barnhardt)

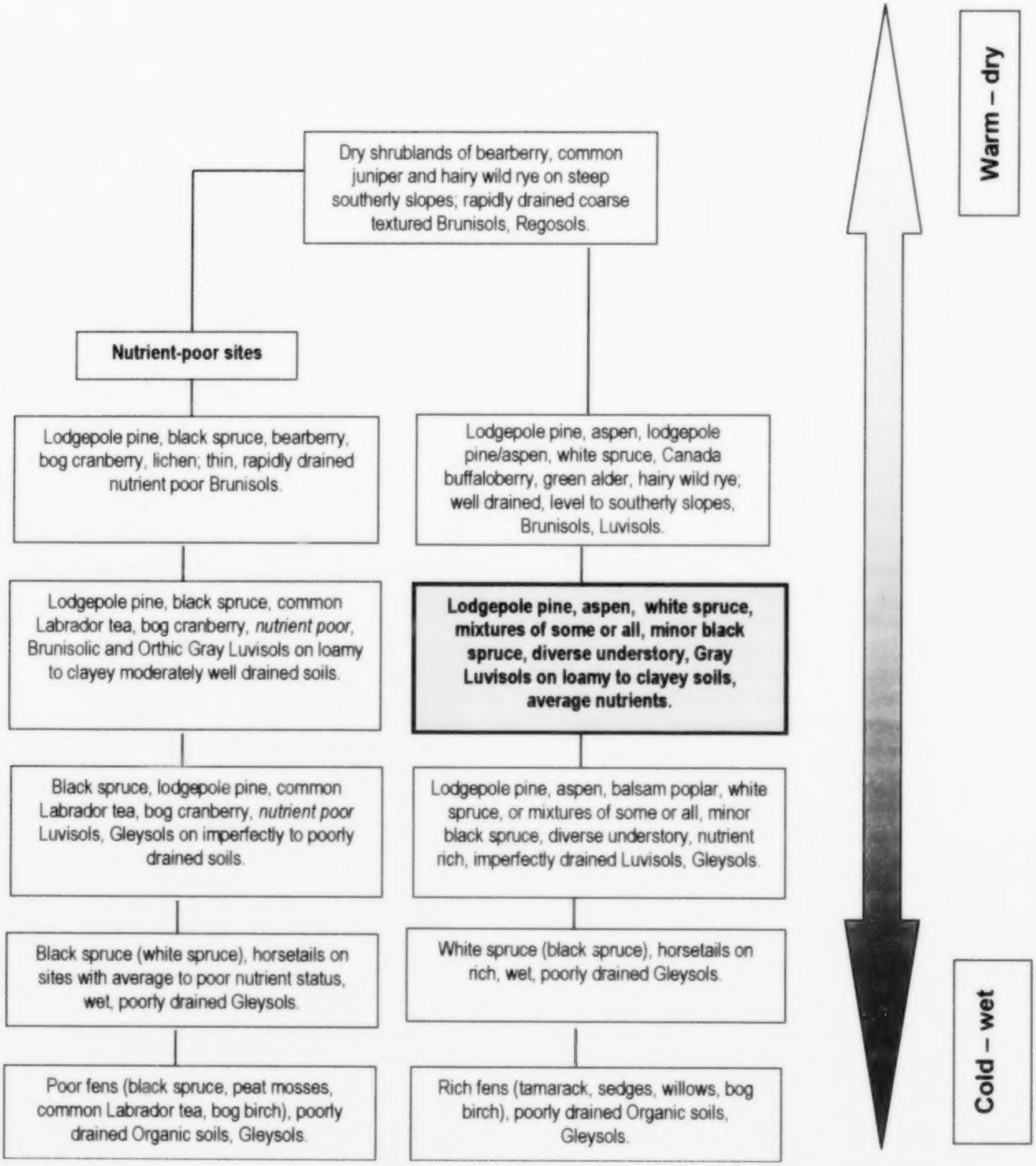
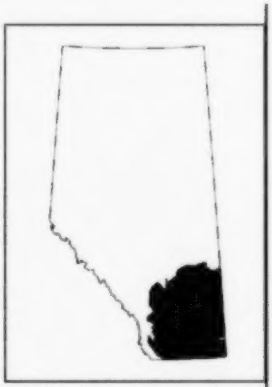

Warm – dry
Dry shrublands of bearberry, common juniper and hairy wild rye on steep southerly slopes; rapidly drained coarse textured Brunisols, Regosols.
Nutrient-poor sites
Lodgepole pine, black spruce, bearberry, bog cranberry, lichen; thin, rapidly drained nutrient poor Brunisols.
Lodgepole pine, aspen, lodgepole pine/aspen, white spruce, Canada buffaloberry, green alder, hairy wild rye; well drained, level to southerly slopes, Brunisols, Luvisols.
Lodgepole pine, black spruce, common Labrador tea, bog cranberry, *nutrient poor*, Brunisolic and Orthic Gray Luvisols on loamy to clayey moderately well drained soils.
Lodgepole pine, aspen, white spruce, mixtures of some or all, minor black spruce, diverse understory, Gray Luvisols on loamy to clayey soils, average nutrients.
Black spruce, lodgepole pine, common Labrador tea, bog cranberry, *nutrient poor* Luvisols, Gleysols on imperfectly to poorly drained soils.
Lodgepole pine, aspen, balsam poplar, white spruce, or mixtures of some or all, minor black spruce, diverse understory, nutrient rich, imperfectly drained Luvisols, Gleysols.
Black spruce (white spruce), horsetails on sites with average to poor nutrient status, wet, poorly drained Gleysols.
White spruce (black spruce), horsetails on rich, wet, poorly drained Gleysols.
Poor fens (black spruce, peat mosses, common Labrador tea, bog birch), poorly drained Organic soils, Gleysols.
Rich fens (tamarack, sedges, willows, bog birch), poorly drained Organic soils, Gleysols.
Cold – wet

Figure 4-2.3. Common ecosystems arranged along environmental gradient, Lower Foothills Natural Subregion. (*Reference site is in blue-shaded box in boldface type.*)

4.3 GRASSLAND NATURAL REGION

Theme



Native prairies and cultivated croplands on vast plains, grassy foothills, warm dry summers and cool, dry winters define the Grassland Natural Region. The semi-arid native prairies of southeastern Alberta merge gradually with taller grasslands and extensively cultivated lands to the north and west, reflecting increasing precipitation; trees grow only along rivers or in moist, protected locales.

Total area: 95,565 km^2 (14.4% of province).

The Grassland Natural Region provides the primary habitat for a number of species, including pronghorn. (Photo: Brian Casement)

General Description

The Grassland Natural Region includes the level to rolling part of Alberta that is sometimes called prairie. Although in its natural state, prairie is thought of as an expanse of grasses, shrublands are found in moister areas. Even forests occur, but they are restricted to coulees and river valleys.

The Grassland Natural Region includes the Dry Mixedgrass, Mixedgrass, Foothills Fescue and Northern Fescue Natural Subregions arrayed in concentric bands from the Alberta–Montana border north to the Grassland–Central Parkland Natural Subregion and west to its boundary with the Foothills Parkland and Montane Natural Subregions.

Chernozemic soils are characteristic of the Grassland Natural Region. Elevations range from about 550 m in the Dry Mixedgrass Natural Subregion near the Alberta–Saskatchewan border, to over 1500 m in the Foothills Fescue Natural Subregion and about 1450 m at the highest elevations of the Mixedgrass Natural Subregion on the Cypress Hills.

Undulating plains are characteristic of much of the Grassland Natural Region, with hummocky uplands also occurring in northern portions along with rolling terrain that is more characteristic of higher elevation areas to the west. Much of the Region has been cultivated, but the remaining native prairies and their associated soils reflect the interactions of dry, warm climates and topography.

Variations in the types of Chernozemic soils are used to differentiate Natural Subregions within the Grassland Natural Region, because extensive cultivation has removed much of the native vegetation and detailed maps of the remaining native plant communities are not available for the entire area. The boundaries between Natural Subregions in the Grassland Natural Region are not as clearly defined as those in the Rocky Mountain and Foothills Natural Regions, reflecting the more gradual influence of latitudinal changes on climate in the comparatively gentle prairie terrain.

Climate

The Grassland Natural Region is the warmest, driest Region in Alberta. The mean annual precipitation of the driest Natural Subregion in Alberta, the Dry Mixedgrass, is only a third of that received by the wettest Natural Subregion, the Alpine. Summers are very warm and the growing season is longer in the Grassland Natural Region than in any other Region.

Precipitation follows a typical continental summer-high pattern, with a maximum in June. There is a pronounced moisture deficit during the latter part of the growing season. Both temperature and precipitation vary with latitude and proximity to the Front Ranges. In the north part of the Region, summer and winter temperatures are slightly lower than in the south and precipitation is higher. A similar increase in precipitation and decrease in summer temperatures occurs in the westernmost part of the Region, but winters are milder due to a higher incidence of Chinooks adjacent to the Front Ranges.

Climate characteristics for the Foothills Fescue Natural Subregion are more similar to the Montane Natural Subregion than to any of the Grassland Natural Subregions. Climate statistics for the Grassland Natural Region are summarized in Table 3-1. Figure 4-3.1 present the annual temperature and precipitation characteristics of the Dry Mixedgrass, Mixedgrass, Northern Fescue, and Foothills Fescue Natural Subregions.

Vegetation

The Grassland Natural Region includes some of the most productive croplands in Alberta, and much of the Region has been cultivated. The characteristic native vegetation form is prairie, with shrublands in areas receiving water and on the cooler north and east aspects. Narrow forests parallel rivers where groundwater provides sufficient moisture for tree growth.

Many prairie species are adapted through dormancy, physiology or anatomy to survive the severe moisture deficits that occur during mid to late summer. In the driest areas (the Dry Mixedgrass Natural Subregion), extensive areas of native prairie remain, typically with a mixture of drought-tolerant, mid-height (e.g., needle-and-thread) and short (e.g., blue grama) grasses. Moister climates to the north and west in the Mixedgrass Natural Subregion support more widespread cultivation.

Semi-arid native prairie of southeastern Alberta.
(Photo: B. Adams)

Where native grasslands remain, they are a mix of taller needle-and-thread, porcupine grass, and northern and western wheatgrasses. Plains rough fescue is the dominant grass on native range in the northernmost Northern Fescue Natural Subregion. Mountain rough fescue, bluebunch fescue and Parry oatgrass grasslands characterize the westernmost Foothills Fescue Natural Subregion, and many species that occur in the Montane and Foothills Parkland Natural Subregion also occur in the Foothills Fescue.

Topography, Geology, Soils and Hydrology

Much of the terrain within the Grassland Natural Subregion is level to gently undulating and is covered by glacial till, lacustrine deposits, and some fluvial and eolian materials. To the west and on the lower flanks of the Cypress Hills and the Milk River Ridge, bedrock-controlled landscapes provide more significant local relief. Bedrock exposures and badland terrain are common along river valleys.

Soil development reflects climatic conditions. In the Dry Mixedgrass Natural Subregion, Brown Chernozems are common and indicate a higher mean annual soil temperature and lower soil organic content (lower organic matter inputs) than the Dark Brown and Black Chernozems typical of the other three Natural Subregions. Soils tend to be calcareous; in places, extensive areas of Solonetzic soils have developed on saline parent materials. Gleysols are associated with wetlands.

Only 1 to 2 percent of the Grassland Natural Region is occupied by water occurring as major rivers and shallow lakes. Wetlands are uncommon and usually temporary in the driest parts of the Region, but permanent marshes occur more frequently to the north and west in response to higher precipitation and lower evaporation.

Appendices 4 and 6 summarize the proportional occurrence of landscape elements, parent materials and soil types in the Grassland Natural Region.

Wildlife Habitats and Populations

The Grassland Natural Region includes many terrestrial and aquatic habitats with distinct wildlife populations. Characteristic species of moderately to heavily grazed prairies include the Horned Lark, McCown's Longspur, Chestnut-collared Longspur and Richardson's ground squirrel. Species associated with lightly grazed grasslands include Baird's Sparrow, Sprague's Pipit, Sharp-tailed Grouse and Upland Sandpiper.

The Richardson's ground squirrel is a key species of the grassland ecosystem. It is an important food source for carrion feeders and a host of predators, such as the Ferruginous Hawk and American badger. Its burrows are used by other mammals, Burrowing Owls, insects, amphibians and snakes, and its diggings are ideal sites for plant colonization. Once very abundant throughout much of the Natural Region, its numbers have declined and in some areas it has become rare or non-existent.

Sand plains and dune fields contain a number of rare and local species restricted to these habitats, including the Ord's kangaroo rat and western hog-nosed snake. More wide-ranging species also occur, such as the Sharp-tailed Grouse, Grasshopper Sparrow and mule deer.

Sand plains provide habitat for a number of specialized plants and animal species. (Photo: L. Allen)

Rock outcrops and badlands provide important habitats for a number of bird species that require these habitats for nesting, including the Golden Eagle, Ferruginous Hawk, Prairie Falcon, Rock Wren, Mountain Bluebird and Say's Phoebe. These habitats also provide shelter and denning sites for the western small-footed bat, long-legged bat and other bat species, bushy-tailed woodrat, yellow-bellied marmot, Nuttall's cottontail, American porcupine, and hibernacula for prairie rattlesnakes, bull snakes, wandering garter snakes and plains garter snakes.

Relatively few permanent standing water habitats exist, and of these, locally extensive marshes contain the most diverse wildlife communities. Common marsh inhabitants include muskrat, Canada Goose, numerous species of dabbling and diving ducks, American Coots, colonies of Red-winged and Yellow-headed Blackbirds, and chorus frogs. Of more local occurrence are the Marsh Wren, American Bittern and colonies of Black-crowned Night-Herons and Franklin's Gulls.

Islands in larger water bodies are important nesting sites for Canada Geese, dabbling duck species, colonies of Ring-billed and California Gulls, and colonies of American White Pelicans and Double-crested Cormorants. Common shoreline birds are the Killdeer, Marbled Godwit, Willet and American Avocet. The American Avocet, Wilson's Phalarope, Northern Shoveler and Cinnamon Teal are some of the few species able to tolerate the highly saline conditions.

Rivers and smaller streams are occupied by a few species of dabbling ducks, Canada Geese, American beaver and muskrat. In addition, a number of species forage here or along the shore, including deer, raccoons, Great Blue Herons and shorebirds. Bank and Rough-winged Swallows, and Belted Kingfishers use holes in cutbanks. Oxbow lakes along meandering streams are key habitats, especially for breeding amphibians such as chorus frogs, leopard frogs, plains spadefoots, plains and wandering garter snakes, and a highly diverse invertebrate community.

Lake chub, flathead chub, white sucker, fathead minnow and brook stickleback are common native fish, the last two species being able to tolerate oxygen-poor conditions and turbidity where other species cannot survive. Several rare or locally occurring fish species are restricted to the Milk River drainage, including the western silvery minnow and stonecat.

The Dry Mixedgrass Natural Subregion contains the most distinctive wildlife assemblage of any of the grassland Natural Subregions. Tall shrub communities in coulees and valleys support bird populations that are strongly associated with the Natural Subregion, such as Brown Thrasher, Gray Catbird, Common Yellowthroat, Yellow-breasted Chat and Rufous-sided Towhee. Woodland communities in valley bottoms include bird populations that also occur in adjacent Natural Regions, such as Mourning Dove, Great-horned Owl, Northern Flicker, Least Flycatcher, House Wren and Northern Oriole.

Tall shrub and woodland communities also include mammals such as deer mouse, Nuttall's cottontail, mule deer and white-tailed deer, the last species preferring riparian woodland. Sagebrush habitats on upland prairie and valley bottoms support species such as Greater Sage Grouse, Lark Bunting, Lark Sparrow, Brewer's Sparrow and pronghorn.

Stream valleys in the extreme south provide unique habitats that support populations of bushy-tailed wood rat, yellow-bellied marmot, Black-headed Grosbeak, Lazuli Bunting, and Bullock's Oriole. These species are rare elsewhere in Alberta.

Notable Features

There are a number of unique features associated with the Grassland Natural Region, including:

- *Badlands, coulees and ravines* associated with the Saskatchewan and Missouri River drainage systems. These harbor rare species such as the short-horned lizard and a number of unusual plant communities.
- *Exposures of intrusive igneous rocks* are found in the extreme south part of the Region associated with the Sweetgrass Hills.
- Unglaciated areas occur on the upper surfaces of the Cypress Hills and Milk River Ridge (Del Bonita Plateau), at elevations over about 1250 m. They are capped with up to 1 m of loess and the underlying gravels often contain relic periglacial features.
- *Small inclusions of Tertiary gravels* on top of the Hand Hills, Wintering Hills, Milk River Ridge and Cypress Hills.
- *The Milk River Upland* along the Alberta–Montana border is associated with a number of unusual plant communities. The Del Bonita Plateau within this Upland is the only location in Canada that the hare-footed locoweed grows.

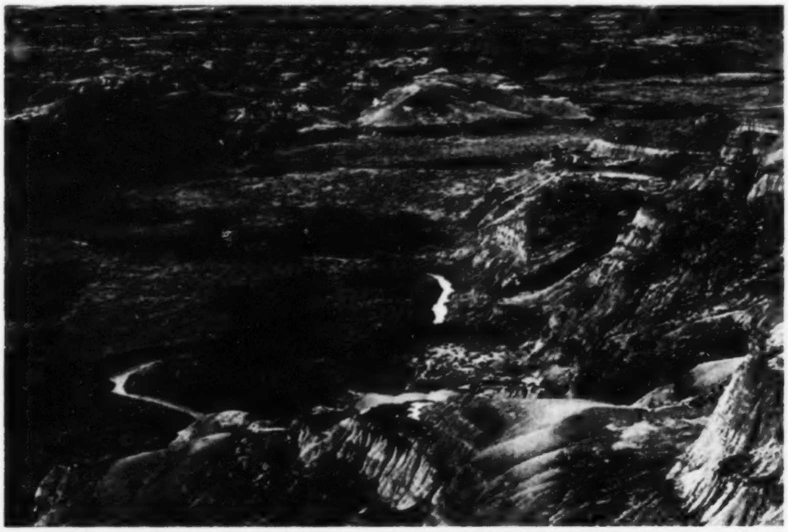
Fauna

- The Grasslands Natural Region contains many animal species that are found nowhere else in Alberta. These include: olive-backed pocket mouse, Ord's kangaroo rat, swift fox, Clark's grebe, Greater Sage-Grouse, Mountain Plover, Sage Thrasher, painted turtle, short-horned lizard, plains hognose snake, western rattlesnake, great plains toad, beautiful tiger beetle, salt creek tiger beetle, ghost tiger beetle, yucca moth, Weidemeyer's admiral butterfly and rhesus skipper. A few of the above-listed species are absent or local in the rest of Canada. Insects such as the yucca moth and Weidemeyer's admiral butterfly are restricted to the lower Milk River area. The dune fields along the river terraces near Bindloss are home to the most northerly North American population of Ord's kangaroo rat.

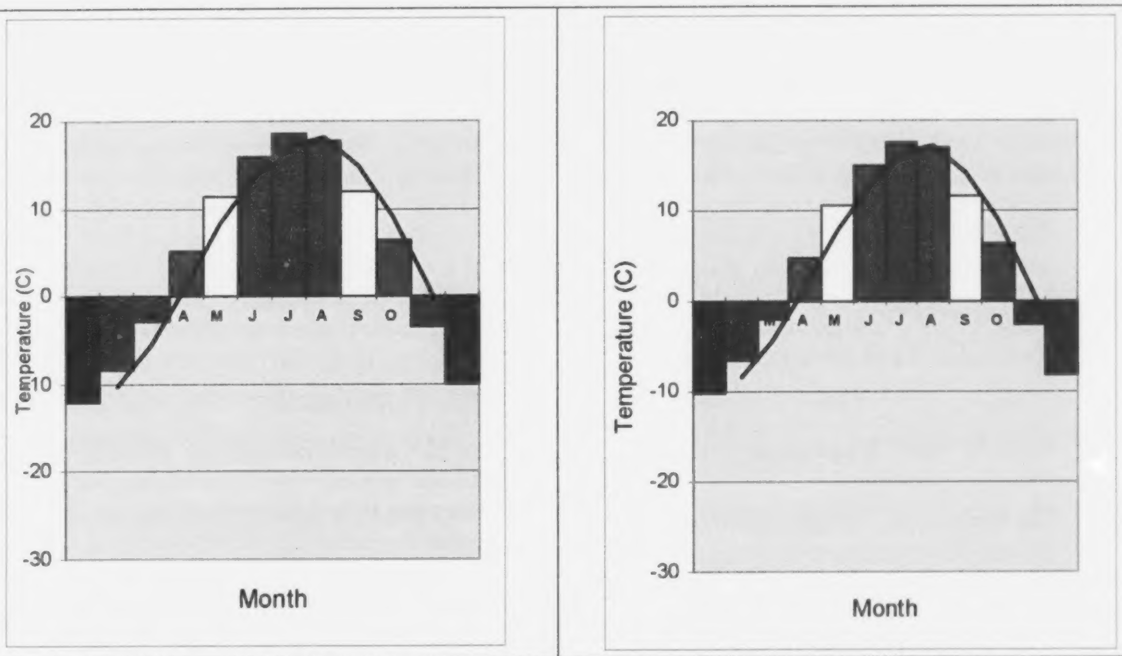
- The range of several endangered and threatened species or species of concern is contained mostly within the boundaries of the Grassland Natural Region. Examples include Burrowing Owl (listed as "Endangered" by COSEWIC, and "Threatened" by the Government of Alberta), Long-billed Curlew (a "Species of Special Concern" by both COSEWIC and the Government of Alberta), and Sprague's Pipit (listed as "Threatened" by COSEWIC, and a "Species of Special Concern" by the Government of Alberta).

Flora

- *About* 125 (25 percent) of Alberta's rare vascular plant species occur in the Grassland Natural Region, and about 55 rare species are restricted in Alberta to this Region—most are at the northern or western edge of their ranges. About half of the rare species grow in grasslands, and the other half in distinct habitats such as wetlands, saline areas, sandy sites and eroded slopes. The southeast corner of Alberta supports a particularly high concentration of rare vascular plant species (Kershaw et al. 2001).

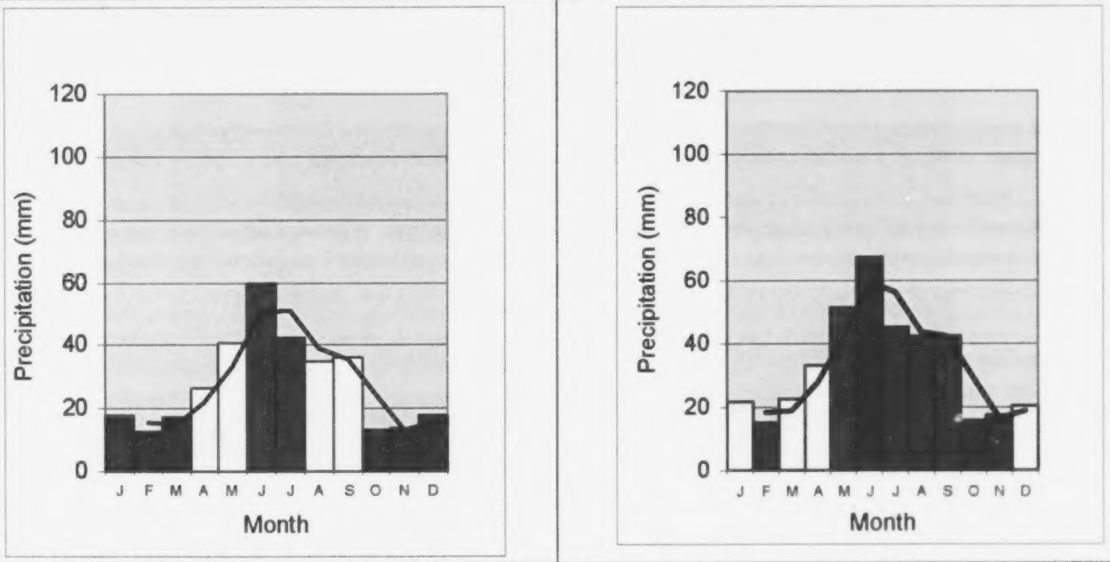


Badlands, coulees and ravines are a significant feature in the natural region. (Photo: L. Allen)



Dry Mixedgrass Natural Subregion
Mean Monthly Temperature (MAT +4.2°C)

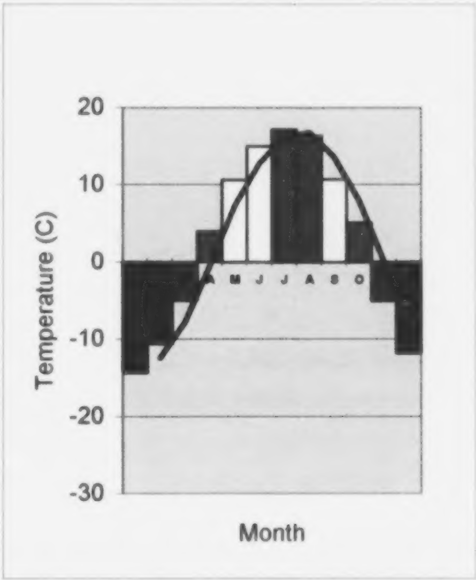
Mixedgrass Natural Subregion
Mean Monthly Temperature (MAT +4.4°C)



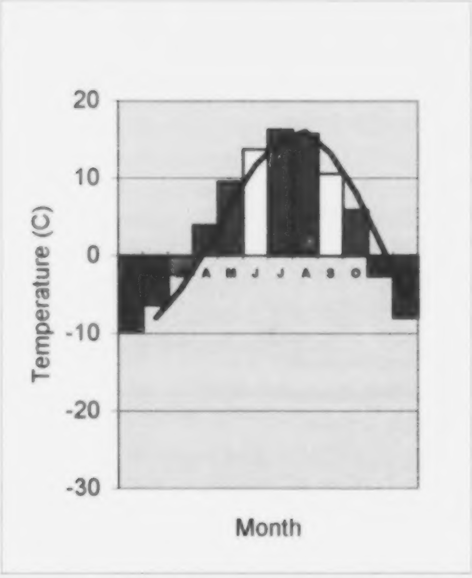
Dry Mixedgrass Natural Subregion
Mean Monthly Precipitation (MAP 333 mm)

Mixedgrass Natural Subregion
Mean Monthly Precipitation (MAP 394 mm)

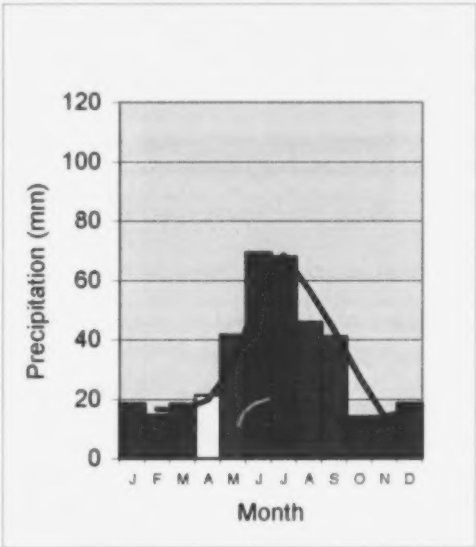
Figure 4-3.1. Grassland Natural Region climate data summaries. (*Refer to footnotes in Figures 3-8 and 3-10 for color scheme explanations.*)



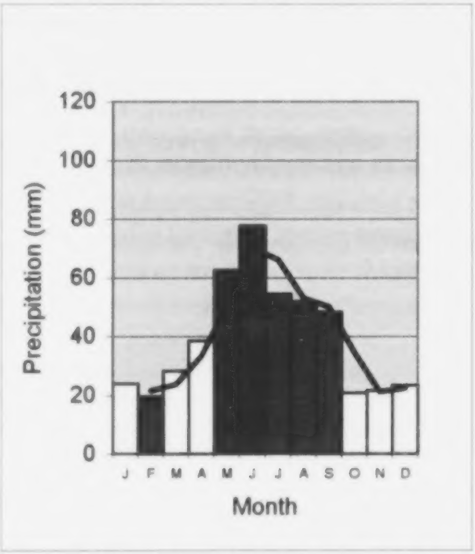
Northern Fescue Natural Subregion
Mean Monthly Temperature (MAT +2.7°C)



Foothills Fescue Natural Subregion
Mean Monthly Temperature (MAT +3.9°C)



Northern Fescue Natural Subregion
Mean Monthly Precipitation (MAP 385 mm)

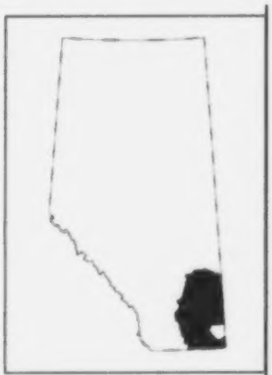


Foothills Fescue Natural Subregion
Mean Monthly Precipitation (MAP 470 mm)

Figure 4-3.1 (concluded). Grassland Natural Region climate data summaries. *(Refer to footnotes in Figures 3-8 and 3-10 for color scheme explanations.)*

4.3.1 Dry Mixedgrass Natural Subregion

Theme



The Dry Mixedgrass Natural Subregion is an expanse of level to gently undulating semi-arid prairie, broken in places by coulees, valleys, badlands and dune fields. The warm, dry climate supports grasses, shrubs and herbs that are adapted to summer droughts. This Natural Subregion provides habitat for numerous species of plants and animals that occur nowhere else in Alberta.

Key Features

- Dry southern prairies dominated by drought-tolerant grasses, shrubs and herbs, or cultivated fields on moister or irrigated areas.
- Brown Chernozemic and Solonetzic soils.
- Trees absent except along rivers or in deep coulees where subsurface water is available.
- Hot summers, high solar inputs, high evaporation, and long cold winters with low snow cover.

Overview (Photo: B. Adams)

Total area: 46,937 km² (49% of Grassland Natural Region).

Average elevation: 800 m (range 575-1100 m).

Prickly-pear is a cactus that is common on these dry landscapes. (Photo: L. Allen)

General Description

The Dry Mixedgrass Natural Subregion is the largest of the four Natural Subregions in the Grassland Natural Region. It occupies the southeastern corner of Alberta at elevations from 550 m near Empress to 1100 m on the lower slopes of the Cypress Hills. Level to gently undulating glacial till or lacustrine plains are the dominant terrain type. Hummocky uplands and sand dunes also occur. Brown Chernozems are the dominant soils, but Brown Solonetzic soils have developed where saline and sodic conditions prevail. The warm, dry climate promotes the development of mixed-height grasslands composed of blue grama and needle-and-thread grass, with sand grass and June grass on sand dunes. Extensive low shrublands with silver sagebrush, silverberry, buckbrush and prickly rose occupy low-lying areas and northerly or easterly aspects. Tall shrub and tree stands are found in coulee or valley bottoms or on sandy soils with perched water tables, where the moisture supply is sufficient to support growth during the summer drought period.

Climate

The Dry Mixedgrass Natural Subregion has the warmest summers, longest growing season and lowest precipitation of any Natural Subregion in Alberta (refer to Table 3-2 for annual and seasonal climatic statistics). The Dry Mixedgrass and Mixedgrass Natural Subregions have similar temperature regimes, but the Dry Mixedgrass Natural Subregion has significantly less growing season precipitation. There is a marked difference between the Dry Mixedgrass and Northern Fescue or Foothills Fescue Natural Subregions as shown by the monthly temperature and precipitation patterns in Figure 4-3.1. These differences are reflected by both vegetation and soil development.

Drying winds, low summer precipitation, high summer temperatures and intense sunshine contribute to significant moisture deficits in mid summer, and many native plants are deep-rooted, short-lived or physiologically adapted (e.g., assume a dormant condition in dry periods). Moisture deficiencies are severely limiting to crop production, and irrigation is often necessary. Winters are cold. Although Chinooks do occur, they are less frequent than in the more westerly Mixedgrass and Foothills Fescue Natural Subregions. Low winter snowfalls provide minimal protective cover for plants and contribute little to soil moisture reserves.

Vegetation

The Dry Mixedgrass Natural Subregion is characterized by low-growing, drought-tolerant mixedgrass communities. Adams et al. (2005a) have integrated the work of other researchers with extensive plot data and classifications, and their syntheses are summarized here. The following simplified synthesis and the diagram in Figure 4-3.2 is adapted from Adams et al. (2005a). Thompson and Hansen (2002) present detailed riparian and wetland vegetation community type descriptions. The term "mixedgrass" refers to the co-dominance of both short and mid-height grasses, of which the most widespread in the Dry Mixedgrass Natural Subregion are blue grama (a short grass) and needle-and-thread, June grass, and western wheat grass (mid-grasses).

Minor differences in local slope and aspect can produce significant changes to plant communities, as can changes in parent material texture and chemistry. Soils at lower slope positions receive more runoff water, with corresponding differences in both plant community and soil development from the top to the bottom of a slope. Sand dunes are rapidly drained and very dry; saline parent materials make water uptake more difficult and halophytic (salt-tolerant) plants are dominant. In addition, grazing can have a marked and long-lasting influence on plant community composition, and short-growing species that are not as subject to grazing pressure as the mid-grasses may assume dominance.

On the driest sites on sand dunes and sand plains, needle-and-thread, sand grass and June grasses grow sparsely on coarse textured Regosols and Rego Chernozems. Lower, moister interdune areas may support shrub communities including silver sagebrush, silverberry, buckbrush and prickly rose. On finer textured materials, the driest sites occur at crests and upper slope locations in undulating to hummocky till. Blue grama is the leading grass species, followed by needle-and-thread and a variety of herbs including moss phlox, pasture sage and prairie selaginella. This vegetation type also occurs on sites with Brown Solonetzic soils. In lower slope positions and on calcareous soils, needle-and-thread assumes dominance.

This is considered the reference site for the Dry Mixedgrass Natural Subregion, and medium to fine textured, well drained Brown Chernozems are typical. In moister locales, western wheatgrass and June grass increase in importance and occur together with needle grasses on loamy, moderately well drained Dark Brown Chernozems. On clayey, moderately well to imperfectly drained sites, western wheat grass and June grass can form nearly pure communities, often on old lakebeds.

Shrub communities, including buckbrush, silver sagebrush, silverberry and prickly rose, occur in places such as depressions, ravines, coulees and northerly aspects where there is a reliable water supply during the growing season. Adjacent to rivers, tall shrub and forest communities of willows, thorny buffaloberry and plains cottonwood develop in response to adequate water supplies from groundwater throughout the growing season. Sedges, spike-rushes and willows occur with Gleysols in wet, poorly drained areas.

Geology and Geomorphology

The Dry Mixedgrass Natural Subregion is characterized by gently undulating glaciated plains with inclusions of hummocky and dissected uplands. It lies mainly in the Eastern Alberta Plains and includes part of the Southern Alberta Uplands on the south side of the Cypress Hills. The underlying bedrock is composed of non-marine Upper Cretaceous sandstones, siltstones and shales with some marine shales. Igneous intrusions occur in a few places in the extreme southern part of this Natural Subregion.

The surficial materials are dominated by medium textured, moderately calcareous glacial till deposits. These range in depth from less than 2 m on some of the gently undulating plains to over 10 m in the more hummocky landscapes. Relatively thin, medium and fine textured glaciolacustrine deposits that were associated with temporary post-glacial lakes blanket about 20 percent of the Dry Mixedgrass Natural Subregion. About 20 percent of the area is also covered by sandy glaciofluvial deposits associated with major post-glacial drainage systems. Appendix 4 summarizes the proportional occurrence of landscape elements and parent materials in the Dry Mixedgrass Natural Subregion.

Water and Wetlands

Only about 2 percent of the Dry Mixedgrass Natural Subregion is water-covered. Newell Lake Reservoir and Pakowki Lake are the largest standing water bodies; major watercourses include the South Saskatchewan, Red Deer, Bow, Milk and Oldman Rivers. There is also a network of irrigation canals. Wetlands are confined to temporary water bodies and marshes associated with landform depressions, and cover about 3 percent of the area.

Soils

Soils in the Dry Mixedgrass Natural Subregion are mainly Orthic Brown Chernozems (about 60 percent of the area) with some Solonetzic intergrades (about 10 percent of the area). Solonetzic soils (Brown Solodized Solonetz, Brown Solod) occupy about 25 percent of the Natural Subregion, mainly occurring with thin glacial till but also on lacustrine and eolian or glaciofluvial deposits.

Sand plains and sand dunes have a high proportion of weakly developed Rego Chernozemic and Regosolic soils. Cultivated lands typically have 5 to 10 percent calcareous eroded knolls with Regosolic or Rego Chernozemic soils. Vertisolic soils are typical of the very fine textured clays of the Acadia Valley area. Wetlands are a mixture of Humic, Orthic and Luvic Gleysols. Appendix 6 summarizes the proportional occurrence of soil types in the Dry Mixedgrass Natural Subregion.

Land Uses

Agriculture is the principal land use in the Dry Mixedgrass Natural Subregion. Grazing is the main agricultural activity, occurring over about 55 percent of the area. About 35 percent of the Natural Subregion is under dry-land farming (mainly wheat/fallow). Nearly 10 percent is under irrigation, mainly in the Taber, Brooks and Medicine Hat areas. Oil and gas exploration and development is extensive throughout. Recreational activities include hunting, camping, fishing and nature appreciation.

Mixed grasses and a variety of herbs typify the Dry Mixedgrass Subregion. (Photo: L. Allen)

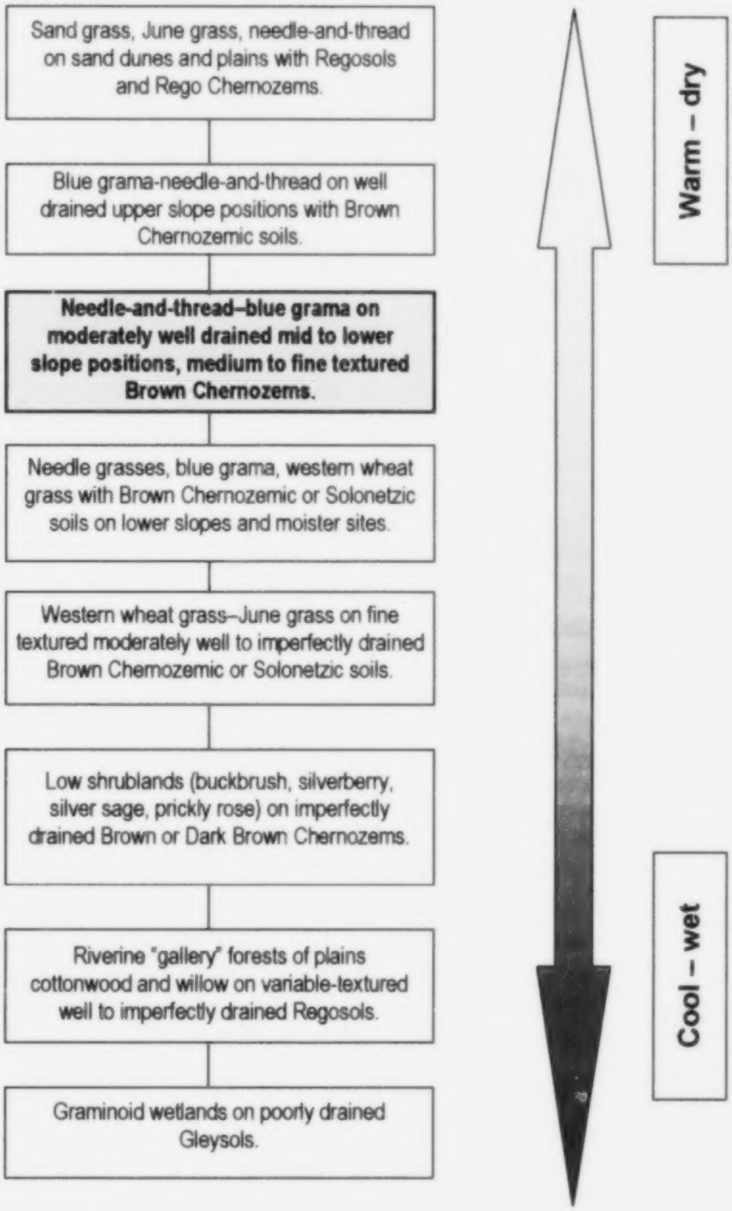
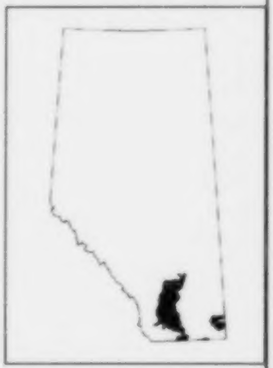

Sand grass, June grass, needle-and-thread on sand dunes and plains with Regosols and Rego Chernozems.
Blue grama-needle-and-thread on well drained upper slope positions with Brown Chernozemic soils.
Needle-and-thread–blue grama on moderately well drained mid to lower slope positions, medium to fine textured Brown Chernozems.
Needle grasses, blue grama, western wheat grass with Brown Chernozemic or Solonetzic soils on lower slopes and moister sites.
Western wheat grass–June grass on fine textured moderately well to imperfectly drained Brown Chernozemic or Solonetzic soils.
Low shrublands (buckbrush, silverberry, silver sage, prickly rose) on imperfectly drained Brown or Dark Brown Chernozems.
Riverine "gallery" forests of plains cottonwood and willow on variable-textured well to imperfectly drained Regosols.
Graminoid wetlands on poorly drained Gleysols.
Warm – dry
Cool – wet

Figure 4-3.2. Common ecosystems arranged along environmental gradient, Dry Mixedgrass Natural Subregion. *(Reference site is in blue-shaded box in boldface type.)*

4.3.2 Mixedgrass Natural Subregion

Theme



The Mixedgrass Natural Subregion is a broad, fertile band of intensively cultivated prairie in south-central Alberta. Slightly higher precipitation than the Dry Mixedgrass Natural Subregion to the east has allowed intensive cultivation over most of the area. At higher elevations, native plains rough fescue and bluebunch fescue grasslands are dominant.

Overview (Photo: B. Adams)

Total area: 20,072 km² (21% of Grassland Natural Region).

Average elevation: 975 m (range 650-1450 m).

Key Features

- Mostly cultivated with scattered remnant prairies; more extensive native rangelands at higher elevations.
- Slightly moister with somewhat cooler summers and milder winters than the Dry Mixedgrass Natural Subregion to the east.
- Dark Brown Chernozemic soils and grasses typical of moist areas in the Dry Mixedgrass Natural Subregion occupy average sites in this Subregion.

Buckbrush is common in shrub communities (Photo: L. Allen)

General Description

The Mixedgrass Natural Subregion curves north from the Alberta–Montana border to the Red Deer River in a 50 to 100 km wide band. Two outliers occur within the Dry Mixedgrass Natural Subregion at middle elevations in the Cypress Hills and on the Sweetgrass Upland along the Montana border. It is bounded on the west by the Foothills Fescue Natural Subregion, on the east by the Dry Mixedgrass Natural Subregion, and on the north by the Northern Fescue Natural Subregion.

Elevations range from about 650 m near the Red Deer River to about 1450 m on the Cypress Hills.

Undulating and hummocky till plains, level lacustrine areas, and undulating to hummocky eolian deposits are typical landforms. Needle-and-thread, porcupine grass, and northern and western wheatgrasses form communities on average sites in remnant prairie areas. Moister conditions on higher areas within the Natural Subregion allow plains rough fescue or bluebunch fescue to become dominant. Dark

Brown Chernozems are the dominant soils, reflecting moister, somewhat cooler conditions than in the adjacent Dry Mixedgrass Natural Subregion.

Climate

The Mixedgrass Natural Subregion is climatically most similar to the Dry Mixedgrass Natural Subregion, but has slightly cooler summers and on average higher annual and growing season precipitation. There is a greater difference between the Mixedgrass and Northern Fescue or Foothills Fescue Natural Subregions, as shown by the monthly temperature and precipitation patterns in Figure 4-3.1, and these differences are reflected in the vegetation development. (Refer to Table 3-2 for annual and seasonal climate statistics.) Adams et al. (2005b) indicate that significantly cooler and moister conditions prevail at higher elevations on the slopes of the Cypress Hills than elsewhere in the Mixedgrass Natural Subregion, and produce corresponding differences in vegetation.

Moisture deficiencies during the summer months may be limiting to crop production, and irrigation is sometimes necessary. Winters are somewhat milder than those in the Dry Mixedgrass Natural Subregion, probably because of a higher incidence of Chinooks. Winter snowfalls are generally low, but are more likely to persist at higher elevations than on the adjacent plains (Adams et al. 2005b), and could therefore contribute to better spring soil moisture.

Vegetation

Native prairies in the Mixedgrass Natural Subregion support community types that are similar to those found in the Dry Mixedgrass Natural Subregion. However, the higher productivity and occurrence of species associated with cooler and moister conditions in the Mixedgrass Natural Subregion differentiate this Subregion from the Dry Mixedgrass. Adams et al. (2005b) have developed a classification for the Mixedgrass Natural Subregion that links site to community type, and integrates previous studies and current analyses. In the simplified synthesis presented below and in Figure 4-3.3, this classification has been merged with the framework provided by Strong and Leggat (1992).

On dry, sandy sites, needle-and-thread, northern wheatgrass, sand grass and June grass form open communities on coarse textured, rapidly drained Regosols and Dark Brown Chernozems; buckbrush may also occur on somewhat moister sites. On somewhat moister, finer textured Dark Brown Chernozems, blue grama grass, needle grasses and northern wheat grass communities occur.

Three reference sites may be recognized according to location and elevation within the Mixedgrass Natural Subregion. All occur on loamy, well drained Dark Brown Chernozems. Elevation-related temperature and precipitation differences likely contribute significantly to plant community differences.

At the highest elevations on the midslopes of the Cypress Hills, plains rough fescue, western porcupine grass and sedges form productive communities. At the somewhat lower elevations and drier climates of the Milk River and Sweetgrass Uplands to the extreme south, bluebunch fescue, northern wheatgrass, needle-and-thread and buckbrush are dominant species. On the lower elevation plains, western and northern wheat grasses, needle-and-thread and June grass are typical of the few remaining undisturbed reference sites.

Shrub communities, including buckbrush, silver sagebrush, silverberry and prickly rose, occur in places such as depressions, ravines, coulees and northerly aspects where there is a reliable water supply during the growing season. Extensive hawthorn shrublands are unique to the lower to mid slopes of the Cypress Hills, usually along minor draws and seepages or other mesic locations.

Adjacent to rivers, tall shrub and forest communities of willows, thorny buffaloberry and narrow-leaf cottonwood or balsam poplar develop in response to adequate water supplies from groundwater throughout the growing season. Balsam poplar is dominant in the Cypress Hills, while plains and narrowleaf cottonwood and balsam poplar occur along the Oldman River. Hybrids of all three species occur in the Lethbridge area, and hybrids of balsam poplar and plains cottonwood occur in the area west of Lethbridge[6]. Sedges, spike-rushes and willows occur with Gleysols in wet, poorly drained areas. Adams et al. (2005b) provide detailed descriptions of grazed and ungrazed vegetation on uplands within the Mixedgrass Natural Subregion. Thompson and Hansen (2002) present detailed summaries of riparian and wetland vegetation communities.

Geology and Geomorphology

The Mixedgrass Natural Subregion lies mostly within the undulating Western Alberta Plains. However, it includes a part of the Southern Alberta Uplands, the lower eastern slopes of the Porcupine Hills, and low- to mid-slope positions on the Cypress Hills and the Sweet Grass Upland. The underlying bedrock is a mixture of Upper Cretaceous non-marine sandstones and siltstones and marine shales, with some Tertiary sandstones and siltstones along the west side.

The surficial materials on the plains are a mixture of silty glaciolacustrine (or eolian) sediments and medium textured glacial till, with some inclusions of glaciofluvial and eolian sands. All are moderately calcareous. The drift thickness is often relatively shallow (often 2 m to 3 m thick) and saline seepage frequently occurs on sloping terrain. On the upland slopes, the material is usually a thicker till deposit. Appendix 4 summarizes the proportional occurrence of landscape elements and parent materials in the Mixedgrass Natural Subregion.

Water and Wetlands

There is only about 1 percent open water in the Mixedgrass Natural Subregion; it is confined to a few irrigation structures and a few rivers (St Mary, Oldman, and Bow Rivers). Wetlands cover about 5 percent of the Mixedgrass Natural Subregion. They are somewhat more common here than in the Dry Mixedgrass Natural Subregion due to slightly increased precipitation; however, they are still mainly ephemeral wetlands and more permanent marshes.

Soils

Soils in the Mixedgrass Natural Subregion are predominantly Orthic Dark Brown Chernozems. Rego Chernozems and Regosols occupy about 5 to 10 percent of the area. These soils are commonly associated with eroded knolls in the cultivated land and with sandy deposits. Saline seeps can occur in sloping landscapes but Solonetzic soils are rare. There may be admixtures of Brown Chernozemic soils in the more arid sites and Black Chernozemic soils on the north slopes of the Milk River Ridge. Wetlands may include Humic, Orthic and Luvic Gleysols. Appendix 6 summarizes the proportional occurrence of soil types in the Mixedgrass Natural Subregion.

Land Uses

The Mixedgrass Natural Subregion is the most intensively cultivated Subregion in Alberta, with about 85 percent of the area planted to annual crops. The principal crop is wheat, but significant barley and canola production also occurs. About 5 percent of the land is under irrigation. The Lethbridge–Picture Butte area is the most intensive livestock feeding area in Canada. Oil and gas exploration and development is common throughout.

Grasslands of mixed species such as wheat grasses, needle-and-thread, and June grass with shrublands such as silverberry in moist pockets typify the Mixedgrass Subregion. (Photo: L. Allen)

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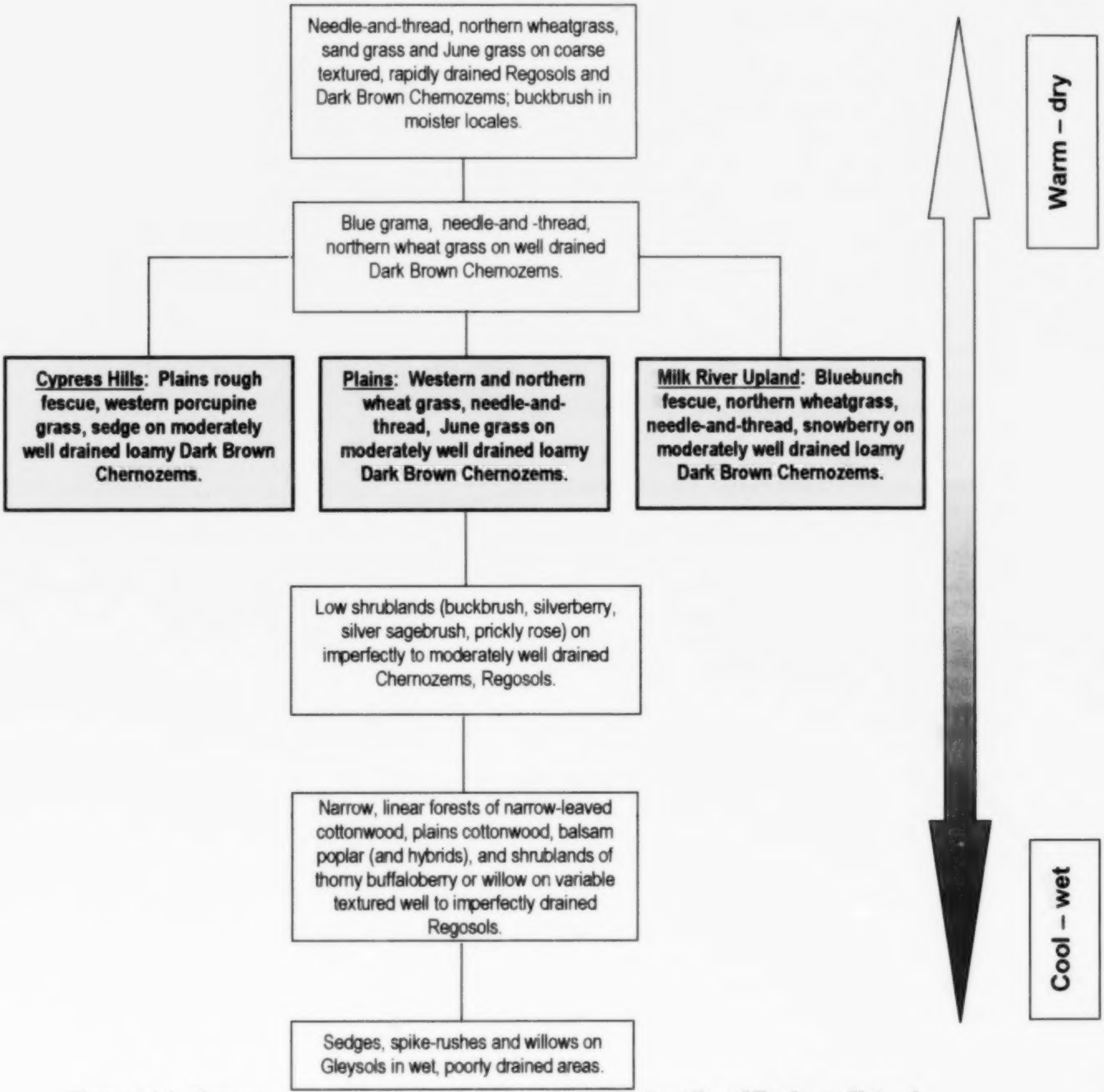
[6] *Floate (1994) provides further information on poplar hybridization in riverine forests of southern Alberta.*



Needle-and-thread, northern wheatgrass, sand grass and June grass on coarse textured, rapidly drained Regosols and Dark Brown Chernozems; buckbrush in moister locales.

Blue grama, needle-and -thread, northern wheat grass on well drained Dark Brown Chernozems.

Cypress Hills: Plains rough fescue, western porcupine grass, sedge on moderately well drained loamy Dark Brown Chernozems.

Plains: Western and northern wheat grass, needle-and-thread, June grass on moderately well drained loamy Dark Brown Chernozems.

Milk River Upland: Bluebunch fescue, northern wheatgrass, needle-and-thread, snowberry on moderately well drained loamy Dark Brown Chernozems.

Low shrublands (buckbrush, silverberry, silver sagebrush, prickly rose) on imperfectly to moderately well drained Chernozems, Regosols.

Narrow, linear forests of narrow-leaved cottonwood, plains cottonwood, balsam poplar (and hybrids), and shrublands of thorny buffaloberry or willow on variable textured well to imperfectly drained Regosols.

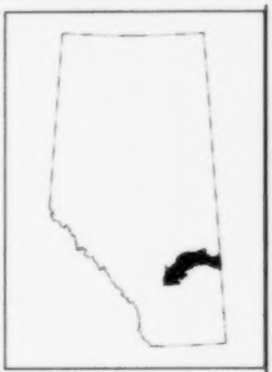
Sedges, spike-rushes and willows on Gleysols in wet, poorly drained areas.

Figure 4-3.3. Common ecosystems arranged along environmental gradient, Mixedgrass Natural Subregion. (*Reference sites are in blue-shaded boxes in boldface type.*)

4.3.3 Northern Fescue Natural Subregion

Theme

A mosaic of cultivated fields and moist native prairie on undulating to hummocky terrain is characteristic of the Northern Fescue Natural Subregion. It represents a climatic transition between the Dry Mixedgrass Natural Subregion and the northern Central Parkland Natural Subregion.



Overview (Photo: L. Allen)

Total area: 14,933 km² (16% of Grassland Natural Region).

Average elevation: 800 m (range 650–1100 m).

Key Features

- About 60 percent cultivated fields and 40 percent grazed native prairie.
- Cooler and moister than the adjacent southerly Mixedgrass and Dry Mixedgrass Natural Subregions; climatically similar to the adjacent Central Parkland Natural Subregion.
- Dark Brown Chernozemic soils are typical on average sites; plains rough fescue is the dominant grass on lightly grazed native range.
- About 60 percent cultivated fields and 40 percent grazed native prairie.

Plains rough fescue is the dominant grass of mesic sites. (Photo: L. Allen)

General Description

The Northern Fescue Natural Subregion occupies a 50 to 80 km-wide crescent, bordered on the north by the Central Parkland Natural Subregion and on the south and west by the Dry Mixedgrass, Mixedgrass and Foothills Fescue Natural Subregions. Elevations range from about 650 m near the Alberta–Saskatchewan border to nearly 1100 m on the Hand Hills southeast of Drumheller.

Hummocky to rolling hill systems with medium textured glacial till deposits occur to the east, south and west; the central portion is a gently undulating fine textured till and lacustrine plain. Plains rough fescue-dominated communities are found on average sites in remnant prairie areas. Drier than average sites in the Northern Fescue Natural Subregion support grasses typical of sites with average moisture in the Mixedgrass and Dry Mixedgrass Natural Subregions; moister sites support shrublands.

Dark Brown Chernozems are the dominant soils, reflecting moister, cooler conditions than in the adjacent Dry Mixedgrass Natural Subregion. Solonetzic soils associated with saline and sodic soils are common in the central plains area.

Climate

The Northern Fescue Natural Subregion is cooler and moister than the Dry Mixedgrass Natural Subregions, reflecting lower solar energy inputs at higher latitudes, the effects of the mid-Alberta summer storm track, and wintertime continental polar air mass influences. It is climatically most similar to the Central Parkland Natural Subregion. Refer to Figure 4-3.1 for a comparison of temperature and precipitation patterns between grassland Natural Subregions, and to Table 3-2 for annual and seasonal climate statistics.

Moisture deficiencies during the summer months may be limiting to crop production, particularly in the southeast portions of the Northern Fescue Natural Subregion. Winter snowfalls are low and comparable to those received in the Dry Mixedgrass Natural Subregion, but are more likely to persist and contribute to spring soil moisture.

Vegetation

Native prairies in the Northern Fescue Natural Subregion include many of the same species that occur in the adjacent Dry Mixedgrass and Mixedgrass Natural Subregions to the south, the Foothills Fescue Natural Subregion to the west, and the northern Central Parkland Natural Subregion.

The dominance of plains rough fescue on reference sites differentiates this Subregion from the other grassland Natural Subregions. In addition, the limited occurrence of aspen and balsam poplar on moist lowland sites differentiates it from the southern Central Parkland Natural Subregion, where aspen groves are more frequent.

Dark Brown Chernozems on cultivated areas also help to distinguish this Natural Subregion from the Central Parkland, Dry Mixedgrass and Foothills Fescue Natural Subregions. Similar soils occur in the Mixedgrass Natural Subregion, but have developed under different grasslands.

In addition to the brief treatment provided by Achuff (1994), Northern Fescue Natural Subregion vegetation has been described as part of a grassland complex by Moss and Campbell (1947), or as transitional between prairie and parkland vegetation types (North 1976; Strong and Leggat 1992). The following summary and Figure 4-3.4 provide a synthesis of these studies for ungrazed to moderately grazed native range sites. Thompson and Hansen (2002) present detailed summaries of riparian and wetland vegetation communities.

Sparsely vegetated grasslands, including blue grama grass, northern wheat grass, sand grass and June grass, occur on the driest sites with coarse textured, rapidly drained Regosols and Rego Chernozems. Western porcupine grass, plains rough fescue, northern wheatgrass and porcupine grass occur on somewhat moister sites with Dark Brown Chernozems.

Communities that are typical of the Northern Fescue Natural Subregion occur on loamy, well drained Dark Brown Chernozems. Plains rough fescue is dominant and forms dense stands on undisturbed sites. On lightly grazed sites, it commonly occurs with western porcupine grass, slender wheat grass, Hooker's oatgrass, and a variety of perennial herbs (e.g., prairie crocus, prairie sagewort, wild blue flax, northern bedstraw, three-flowered avens).

Weakly saline, moderately well drained sites support communities similar to those described by Adams et al. (2005b) in the adjacent Mixedgrass Natural Subregion. Western wheat grass, June grass and sedges may be expected on Solonetzic, Solodized Solonetzic, and Solonetzic Dark Brown Chernozemic soils. Moist, moderately well drained sites often support shrub communities (buckbrush, silverberry, prickly rose and saskatoon) on Dark Brown Chernozems.

Balsam poplar, aspen and plains cottonwood stands are limited to river valleys where groundwater is adequate throughout the growing season; hybrids of plains cottonwood and balsam poplar also occur. Willow, sedge, common cattail and bulrush communities occur in poorly drained depressions and along rivers on Gleysolic soils.

Geology and Geomorphology

The Northern Fescue Natural Subregion includes a central gently undulating plain bordered by the hummocky and rolling Neutral Hills on the east and the Hand Hills, Wintering Hills and Drumheller basin to the west and south. The underlying bedrock is mainly a mixture of Cretaceous sediments, composed of marine shales and nonmarine sandstones and mudstones with some coal seams. More resistant Tertiary and Cretaceous sandstone-dominated formations underlie the Hand Hills and Wintering Hills in the southwest and westerly parts of the Natural Subregion.

Surficial deposits are mainly moderately fine, slightly saline and calcareous glacial tills in the central plain and medium textured till in the adjacent uplands. Fine clays of the Drumheller basin cover about 20 percent of the area, and glaciofluvial and eolian sands associated with the Sounding Creek drainage also occupy about 20 percent of the Natural Subregion.

Appendix 4 summarizes the proportional occurrence of landscape elements and parent materials in the Northern Fescue Natural Subregion.

Water and Wetlands

Only 3 percent of the total area is covered by water, mainly in small lakes of which the largest are Sullivan Lake, Chain Lakes and Gough Lake. The Red Deer River is the only major river to traverse the area. Five percent of the area is occupied by wetlands, mainly occurring as temporary wetlands and marshes; alkali wetlands are relatively common.

Soils

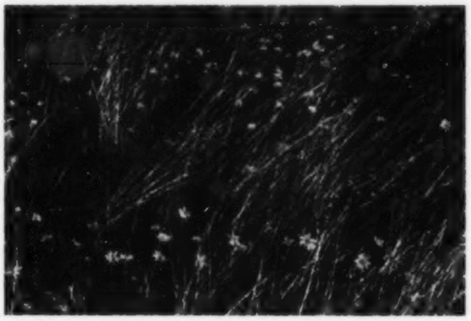
Orthic Dark Brown Chernozems are the principal soils but there are some notable exceptions. About 25 percent of the Natural Subregion, mainly in the central plains, is dominated by Solonetzic soils (Solodized Solonetz and Solod), with associated Solonetzic Dark Brown Chernozems. Vertisolic soils are significant components associated with fine-textured clays of the Drumheller Basin. Regosols and Rego Chernozems are associated with eroded knolls, especially in cultivated areas.

Black Chernozems also occur at upper elevations where conditions are moister and humus inputs are greater. Orthic, Humic and Luvic Gleysols are typical of wetland areas. Saline phases of these soils are common in areas where upland soils are predominantly Solonetzic.

Appendix 6 summarizes the proportional occurrence of soil types in the Northern Fescue Natural Subregion.

Land Uses

Agriculture is the primary land use. About 55 percent of the area is annually cultivated, but the extent ranges from 80 percent on the better quality Chernozemic loams to about 25 percent in sandy and Solonetzic areas. Wheat is the main crop, and barley and canola production are also important. Domestic grazing occurs across the remainder of the area. There is significant oil and gas activity, and surface coal mining occurs as well. The relatively long summer season provides recreational opportunities such as camping and nature appreciation.



Plains rough fescue forms dense stands on reference sites. (Photo: L. Allen)

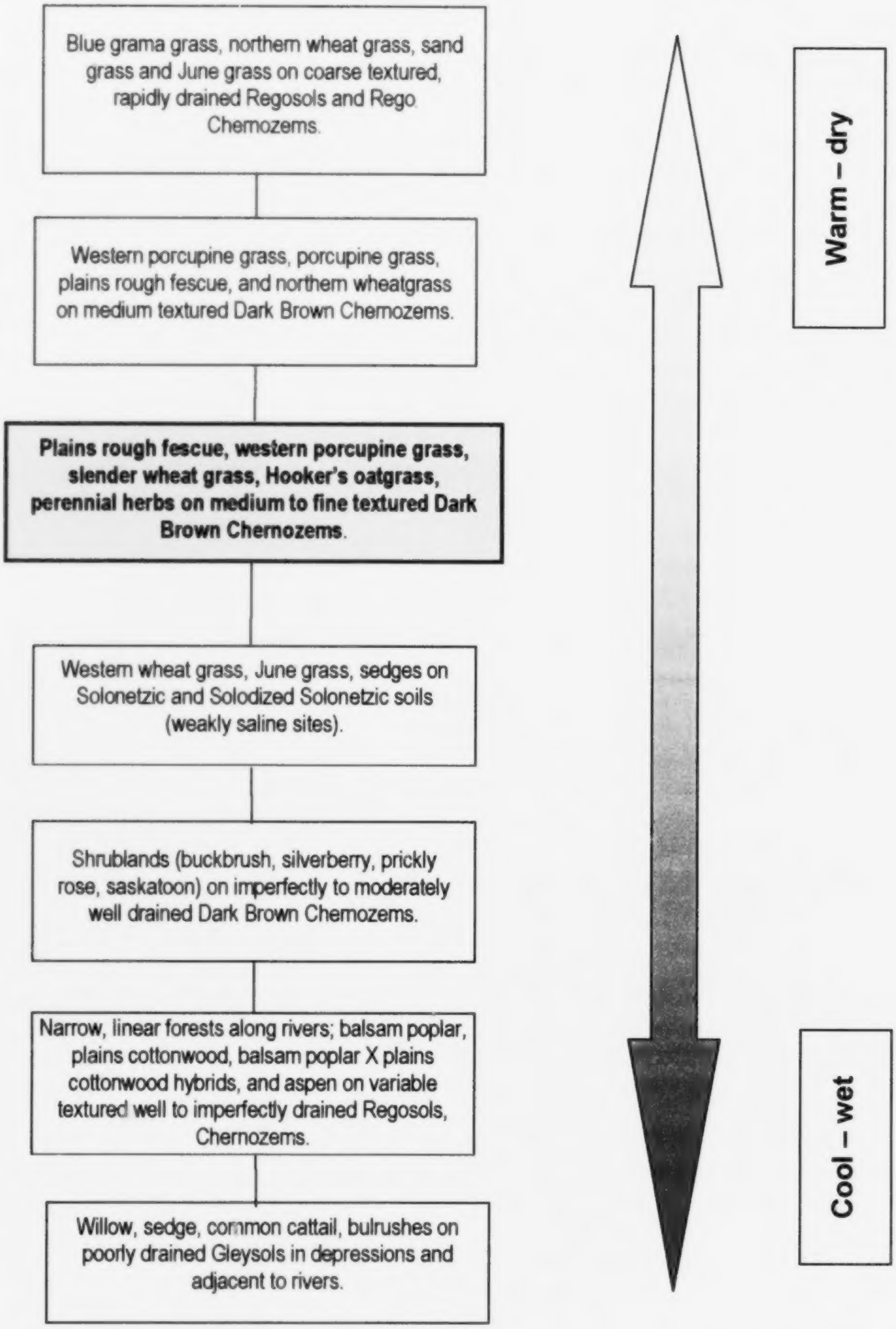
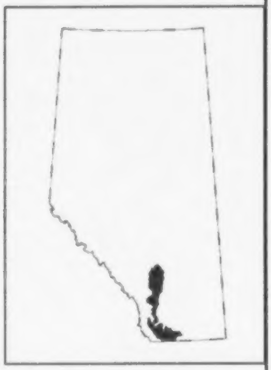

Blue grama grass, northern wheat grass, sand grass and June grass on coarse textured, rapidly drained Regosols and Rego Chernozems.
Western porcupine grass, porcupine grass, plains rough fescue, and northern wheatgrass on medium textured Dark Brown Chernozems.
Plains rough fescue, western porcupine grass, slender wheat grass, Hooker's oatgrass, perennial herbs on medium to fine textured Dark Brown Chernozems.
Western wheat grass, June grass, sedges on Solonetzic and Solodized Solonetzic soils (weakly saline sites).
Shrublands (buckbrush, silverberry, prickly rose, saskatoon) on imperfectly to moderately well drained Dark Brown Chernozems.
Narrow, linear forests along rivers; balsam poplar, plains cottonwood, balsam poplar X plains cottonwood hybrids, and aspen on variable textured well to imperfectly drained Regosols, Chernozems.
Willow, sedge, common cattail, bulrushes on poorly drained Gleysols in depressions and adjacent to rivers.
Warm – dry
Cool – wet

Figure 4-3.4. Common ecosystems arranged along environmental gradient, Northern Fescue Natural Subregion. (*Reference site is in blue-shaded box in boldface type.*)

4.3.4 Foothills Fescue Natural Subregion

Theme

Nearly level cultivated plains in the north and cool, high-elevation grassy uplands along the mountain flanks to the south characterize the Foothills Fescue Natural Subregion.



Key Features

- Cooler summers and shorter growing seasons, but warmer winters and more precipitation than other grassland Natural Subregions.
- Black Chernozemic soils are typical on average sites; mountain rough fescue and bluebunch fescue are the dominant grasses on lightly grazed native range.
- Grasslands have a diverse herb component, with a number of species not prominent in the other grassland Natural Subregions, such as sticky purple geranium and silvery perennial lupine.
- Fifty percent cultivated, with about 80 percent native prairie in the south at higher elevations.

Overview (Photo: B. Adams)

Total area: 13,623 km^2 (14% of Grassland Natural Region).
Average elevation: 1100 m (range 800-1525 m).

Sticky purple geranium is prominent in the subregion. (Photo: L. Allen)

General Description

The Foothills Fescue Natural Subregion occupies an irregular south-north belt between 15 to 100 km wide, extending north from the Alberta–Montana border to northwest of Drumheller. Adjacent Natural Subregions are the Central Parkland and Northern Fescue to the north, the Foothills Parkland to the west, and the Mixedgrass to the east. It lies directly adjacent to the Montane Natural Subregion at lower elevations in the Porcupine Hills and in the Crowsnest Pass area. This is the highest grassland Natural Subregion, with elevations ranging from 800 m in the north near Drumheller to over 1500 m on the east slopes of the Porcupine Hills.

Rolling to hummocky uplands are typical of the southern and western portions of this Subregion, with undulating plains to the north and east. Mountain rough fescue-dominated communities are found on average sites in remnant prairie areas, but most of the area is cultivated. Black Chernozems are the dominant soils, reflecting moister, cooler conditions and the incorporation of relatively high organic matter. Open water and wetlands are uncommon in the hillier foothills area.

Climate

The Foothills Fescue Natural Subregion has the highest precipitation, warmest winters and shortest growing season of any of the grassland Natural Subregions. Proximity to the mountains and a greater incidence of Chinooks are both responsible for these characteristics. This Natural Subregion is climatically more similar to the Foothills Parkland and Montane Natural Subregions than it is to any of the grassland Natural Subregions. The month of maximum precipitation is June as it is for the other grassland Natural Subregions, but the Foothills Fescue Natural Subregion also receives significant precipitation in May. Figure 4-3.1 provides a comparison of temperature and precipitation patterns between grassland Natural Subregions, and Table 3-2 gives annual and seasonal climate statistics.

Vegetation

The Foothills Fescue Natural Subregion has many plant species in common with the adjacent Mixedgrass, Foothills Parkland and Montane Natural Subregions. Grass-dominated native communities on reference sites differentiate this Natural Subregion from the Montane, Foothills Parkland and Central Parkland Natural Subregions which are characterized by forested or shrubby reference sites.

The prevalence of mountain rough fescue, Parry oat grass and bluebunch fescue on reference sites separates the Foothills Fescue Natural Subregion from the Mixedgrass and Northern Fescue Natural Subregions; shrubby cinquefoil is also common, particularly on grazed sites.

Shrubby cinquefoil can be locally abundant.
(Photo: L. Allen)

Black Chernozems on cultivated areas also distinguish this Natural Subregion from the Mixedgrass and Northern Fescue Natural Subregions. Similar soils occur in the Montane, Foothills Parkland and Central Parkland Natural Subregions, but they have developed under different vegetation. Approximately 50 percent of the Foothills Fescue Natural Subregion is cultivated.

Foothills Fescue Natural Subregion upland vegetation has been described in detail by Adams et al. (2003). The following summary and Figure 4-3.5 is a synthesis of this work for ungrazed to moderately grazed native prairies. The general discussions presented by Strong and Leggat (1992) and Thompson and Hansen (2002) for moister shrub and tree-dominated sites are also included.

Very dry, steep southwest slopes with thin Chernozemic or Brunisolic soils are sparsely vegetated by communities that include creeping juniper, Parry oatgrass, bluebunch fescue and June grass. With increasing soil moisture, mountain rough fescue becomes a more important component. Dry, well drained sites on Black Chernozemic soils support mixtures of mountain rough fescue, bluebunch fescue, Parry oat grass and June grass.

Reference sites on loamy, well drained Black Chernozems in the southern half of the Foothills Fescue Natural Subregion are typically vegetated by mountain rough fescue, bluebunch fescue, sedges and western wheat grass. In the north half, adjacent to the Foothills Parkland Natural Subregion under somewhat moister conditions, mountain rough fescue and Parry oat grass are common associates on loamy Black Chernozems with thick black humus horizons. Silvery perennial lupine, sticky purple geranium, three-flowered avens, pasture sagewort and golden bean are common herbs throughout the Foothills Fescue Natural Subregion.

Moist, moderately well drained sites often support shrub communities (buckbrush, silverberry, prickly rose and saskatoon) on well to imperfectly drained Black Chernozems. Shrubby cinquefoil can be locally abundant where moderate to heavy grazing has occurred. Along rivers, balsam poplar, aspen and plains cottonwood stands occur on lower terraces, with hybrids of balsam poplar and plains cottonwood. Willow, sedge and tufted hair grass communities occur on loamy Humic Gleysols in poorly drained depressions and along rivers.

Geology and Geomorphology

The Foothills Fescue Natural Subregion includes part of the rolling Southern Alberta Uplands and Foothills, and extends northward into the undulating to rolling Western Alberta Plains. The underlying bedrock includes both Tertiary and Upper Cretaceous sandstones and mudstones.

Surficial materials are dominantly medium-textured, moderately calcareous glacial till. Till deposits can be quite thin in steep areas, with occasional bedrock exposures. About 25 percent of the area is covered by fine and medium textured glaciolacustrine materials. Sandy and gravelly glaciofluvial deposits occur within and adjacent to river valleys. Unique features include the level, unglaciated upper portions of the Del Bonita Plateau, which feature loess-capped gravels with periglacial features. Appendix 4 summarizes the proportional occurrence of landscape elements and parent materials in the Foothills Fescue Natural Subregion.

Water and Wetlands

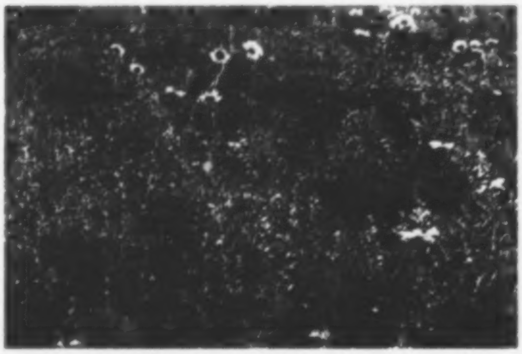
Only about 1 percent of the Foothills Fescue Natural Subregion is occupied by water, mainly in the Waterton, Oldman, Bow and St. Mary Rivers. The St. Mary Reservoir is the largest lake. Wetlands are uncommon, occurring over about 3 percent of the Subregion, and are mainly confined to depressions in undulating to hummocky terrain.

Soils

Orthic Black Chernozems are the dominant soils in the Foothills Fescue Natural Subregion. Dark Brown Chernozems occur on exposed southern slopes and in the wind-eroded farmlands of the Pincher Creek area, and there are some saline soils on the irrigated plains. Humic Gleysols are associated with wetlands. Appendix 6 summarizes the proportional occurrence of soil types in the Foothills Fescue Natural Subregion.

Land Uses

Agriculture is the principal land use, but the amount of cultivation is quite variable ranging from 80 percent in the plains to less than 20 percent in the hilly uplands where grazing predominates. At higher elevations, the growing season is too short for wheat, and barley and forage crops are more commonly grown. There is significant oil and gas activity in the foothills, and the Subregion is popular for recreation, especially in the south.



In the Foothills Fescue Subregion, mountain rough fescue-dominated grasslands are common and often herb-rich with characteristic species such as silvery perennial lupine. (Photo: L. Allen)

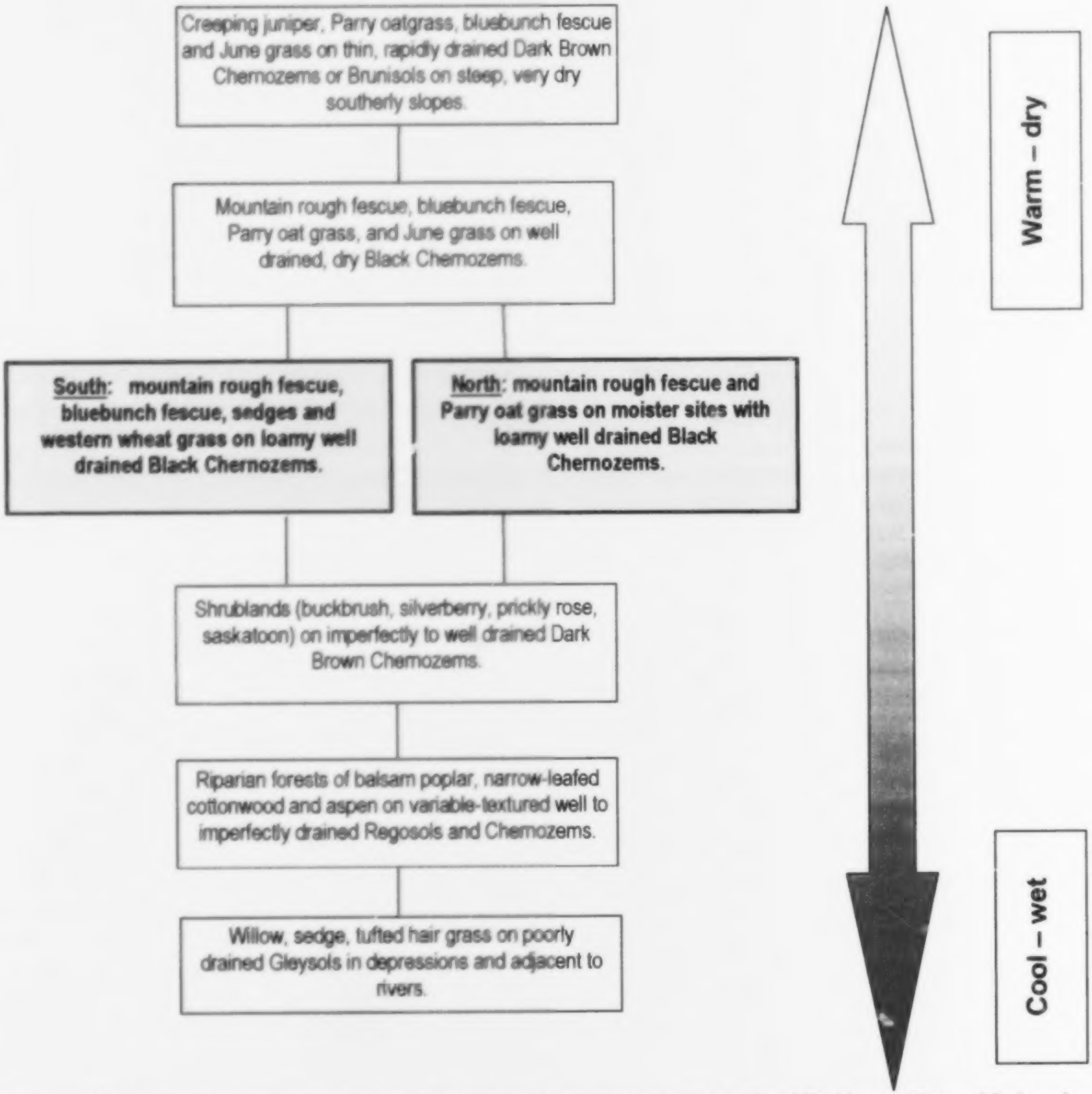
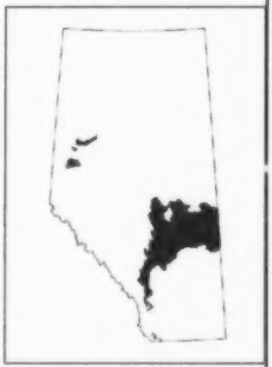

Creeping juniper, Parry oatgrass, bluebunch fescue and June grass on thin, rapidly drained Dark Brown Chernozems or Brunisols on steep, very dry southerly slopes.
Mountain rough fescue, bluebunch fescue, Parry oat grass, and June grass on well drained, dry Black Chernozems.
South: mountain rough fescue, bluebunch fescue, sedges and western wheat grass on loamy well drained Black Chernozems.
North: mountain rough fescue and Parry oat grass on moister sites with loamy well drained Black Chernozems.
Shrublands (buckbrush, silverberry, prickly rose, saskatoon) on imperfectly to well drained Dark Brown Chernozems.
Riparian forests of balsam poplar, narrow-leafed cottonwood and aspen on variable-textured well to imperfectly drained Regosols and Chernozems.
Willow, sedge, tufted hair grass on poorly drained Gleysols in depressions and adjacent to rivers.
Warm – dry
Cool – wet

Figure 4-3.5. Common ecosystems arranged along environmental gradient, Foothills Fescue Natural Subregion.
(Reference sites are in blue-shaded boxes in boldface type.)

4.4 PARKLAND NATURAL REGION

Theme



Remnant patches of aspen and willow shrublands mixed with native grasslands, underlain by black soils and surrounded by productive agricultural lands and urban landscapes, is characteristic of the present-day Parkland Natural Region. Cool, moist Cordilleran climates along the foothills of the Front Ranges, and transitional boreal climates in the plains of central and northwestern Alberta produce three distinct divisions of this Natural Region.

- Total area: 60,747 km^2 (9% of province).

Wetland habitats support diverse wildlife such as large populations of breeding ducks, including Mallards. (Photo: D. Vujnovic)

General Description

The Parkland Natural Region includes the Foothills Parkland, Central Parkland and Peace River Parkland Natural Subregions. Of these, the Central Parkland Natural Subregion is the most extensive, occurring in a broad arc from 200-250 km wide in central Alberta, narrowing to about 50 km where it joins the Foothills Parkland Natural Subregion in west-central Alberta.

The Foothills Parkland Natural Subregion occupies a discontinuous and narrow band along the foothills, extending south to the Alberta–Montana border. The Peace River Parkland occurs in three isolated patches in northwestern Alberta. Elevations range from 300 m in the Peace River Parkland Natural Subregion to about 1600 m in the Foothills Parkland Natural Subregion.

Undulating till plains and hummocky uplands are characteristic of the Central and Peace River Parklands. Rougher foothills terrain and steep, slumping river valley slopes are attributes of the Foothills and Peace River Parkland Natural Subregions, respectively.

The Parkland Natural Region is the most densely populated Natural Region in Alberta, and has been extensively cultivated since the late 1800s. The Natural Region has been strongly influenced by agriculture, and soil types have been used to define its boundaries.

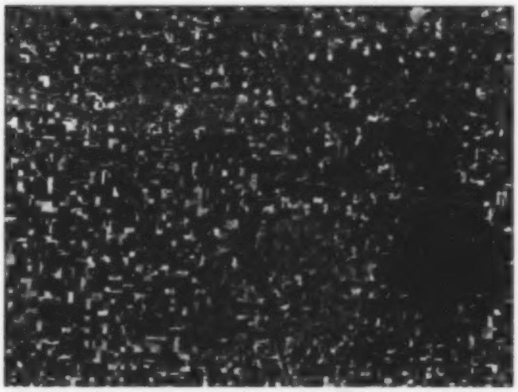
Climate

The Parkland Natural Region represents a climatic transition between the Grassland and Cordilleran ecoclimatic provinces to the south and west (i.e., the Foothills Parkland Natural Subregion) and the Grassland and Boreal ecoclimatic provinces to the north (i.e., the Central Parkland Natural Subregion). Climate and unique site conditions together define the present extent of the Peace River Parkland Natural Region.

Mean annual temperature, growing season and mean annual precipitation values are intermediate between the Grasslands Natural Region to the south and the adjacent Rocky Mountain or Boreal Natural Regions to the west and north. Winters are cooler in the more northerly Peace River Natural Subregion because of more pronounced continental polar influences, and warmer in the Foothills Parkland Natural Subregion because of Chinooks. Climate statistics for the Parkland Natural Region are summarized in Table 3-1. Figure 4-4.1 presents the annual temperature and precipitation characteristics of the Foothills Parkland, Central Parkland and Peace River Parkland Natural Subregions.

Vegetation

The Parkland Natural Region includes highly productive croplands, and most of the Region has been cultivated. The characteristic remaining native vegetation is usually an aspen–grassland mosaic; an area in the Foothills Parkland Natural Subregion has a willow–grassland mosaic.



Cultivation now occupies a significant portion of the parkland landscape.

Grasslands are the dominant native vegetation in the southern part of the Region, and islands of aspen forest or patches of willow shrubland occur in moist depressions or on northerly aspects. To the north, aspen stands occupy a wider range of habitats, and closed aspen and balsam poplar stands with grassland inclusions are typical of the northern Central Parklands Natural Subregion.

The Peace River Parkland Natural Subregion is a complex of closed aspen stands and grasslands on uplands, the latter occurring mainly on Solonetzic soils, and on steep south-facing river valley slopes. Remnant Parkland vegetation also includes wet, low-lying areas unsuitable for agriculture. These are most common in the northern Central Parkland and upland Peace River Parkland Natural Subregions, and support cattail marshes, willow–sedge shrublands or treed fens.

Topography, Geology, Soils and Hydrology

Much of the Parkland Natural Subregion is level to gently undulating, and is covered mainly by glacial till. These areas are usually cultivated. Remnant Parkland vegetation occurs on hummocky to rolling terrain where cultivation is difficult. Fine textured glaciolacustrine deposits are common in valleys within the Central Parkland and Foothills Parkland Natural Subregions, and across most of the Peace River Parkland Natural Subregion. Fluvial deposits occur along major river valleys and there are also significant eolian deposits, with colluvium due to slumping and erosion along the Peace River.

Black Chernozems are the dominant soils under grasslands or in cultivated areas of the Foothills Parkland and much of the Central Parkland Natural Subregions. They reflect the long-term occurrence of productive grasslands that developed under relatively long, warm growing seasons and the resulting incorporation of organic matter into deep black surface humus layers.

In the somewhat cooler Peace River Natural Subregion and in the forested parts of the Foothills Parkland and Central Parkland Natural Subregion, Dark Gray Chernozems are more common than Black Chernozems because of lower soil temperatures and lower rates of humus formation. Solonetzic soils develop where weakly saline and sodic parent materials occur, and cover significant areas in the Central Parkland and Peace River Parkland Natural Subregions. Gleysols are associated with wetlands.

Wetlands are uncommon in the Foothills Parkland Natural Subregion, but occur over 5 to 10 percent of the Central Parkland and Peace River Parkland Natural Subregions. The Peace, Smoky, North Saskatchewan, Red Deer and Bow Rivers are the major watercourses within the Parkland Natural Region.

Appendices 4 and 6 summarize the proportional occurrence of landscape elements, parent materials and soil types in the Parkland Natural Region.

Wildlife Habitats and Populations

The Parkland Natural Region shares climatic, vegetation and soil characteristics in common with bordering Natural Regions. Habitats are home to wildlife species that include both the Parkland and adjacent Natural Regions within their range. Although few species are unique to the Parkland Natural Region, diverse plant communities create distinct habitats and wildlife assemblages.

The Central Parkland Natural Subregion blends wildlife elements from the Northern Fescue Natural Subregion to the south and the Dry Mixedwood Natural Subregion to the north and west. Grassland species such as the Upland Sandpiper, Sprague's Pipit and Baird's Sparrow are common in the south and less common to the north and west, where boreal species like the woodchuck, Broad-winged Hawk and Rose-breasted Grosbeak are more common.

Species within the aspen and willow communities throughout the Central Parkland Natural Subregion include the Red-tailed Hawk, Least Flycatcher, Baltimore Oriole, Red-eyed Vireo, Yellow Warbler, white-tailed deer, snowshoe hare, northern pocket gopher and American porcupine. These wide-ranging species are also typical of deciduous woodlands in the Boreal Forest Natural Subregion, and of riparian woods in the Grassland Natural Subregion.

Sand plains and sand dunes include species such as the Hermit Thrush, thirteen-lined ground squirrel and Sharp-tailed Grouse. Tall shrub and woodland communities at the margins of interdunal wetlands in eastern Alberta provide habitat for Boreal species such as American Redstart and Tennessee Warbler. The plains spadefoot toad has been recorded in wetlands in the extreme southeast part of the Central Parkland Natural Subregion; it is most commonly found in sandy areas in the Grassland Natural Region.

River valley forests and shrublands in the Central Parkland Natural Subregion include many of the same species that occur in the Grassland Natural Region such as the Mourning Dove, Great-horned Owl, Northern Flicker, Least Flycatcher, House Wren and Northern Oriole. Southern Boreal species include Blue Jay, White-throated Sparrow, Yellow-bellied Sapsucker, red squirrel and least chipmunk.

Aquatic and wetland habitats support diverse wildlife populations throughout the Parkland Natural Region. Species of lakes and wetlands include diving ducks, grebes, American Bittern, Marsh Wren and Black Tern, all of which also occur in the Grassland Natural Region. The boreal chorus frog, wood frog and Canadian toad are typical wetland amphibians; the plains garter snake is a also a common resident of the Central Parkland Natural Subregion. Northern pike, yellow perch and white sucker are common fish species; brook stickleback and fathead minnow are present in oxygen-poor environments.

Only one vertebrate species, the prairie vole, appears to be restricted primarily to the Central Parkland Natural Subregion. Two other species with primary ranges in the Central Parkland are Franklin's ground squirrel, which ranges northward into the southern Boreal Forest Natural Region, and Piping Plover, which ranges south to the Grasslands Natural Region.

The Foothills Parkland Natural Subregion contains wildlife found mainly in the Rocky Mountain Natural Region, including Dusky Flycatcher, MacGillivray's Warbler, Lazuli Bunting and White-crowned Sparrow. In tall willow shrubbery, species include Clay-colored Sparrows, Orange-crowned Warblers and Yellow Warblers, Alder Flycatchers, White-crowned Sparrows. Moose also occur. In the aspen woodlands in the southern part of the Foothills Parkland Natural Subregion, populations of Black-headed Grosbeaks and Blue Grouse are found.

The Peace River Parkland Natural Subregion has wildlife populations that are most similar to the adjoining Boreal Forest Natural Region. Remnant native grasslands in the Peace River

Parkland support disjunct populations of at least nine species of butterfly that are associated with prairie habitats.

Lakes and ponds in the Peace River Parkland constitute one of the major nesting areas for the Trumpeter Swan (listed as "Threatened" by the Government of Alberta). Common fish in the Peace River Parkland include the flathead chub, lake chub, longnose dace, longnose sucker, northern pike and trout-perch. Three species are restricted to the Peace River system—the redside shiner, northern squawfish and largescale sucker.

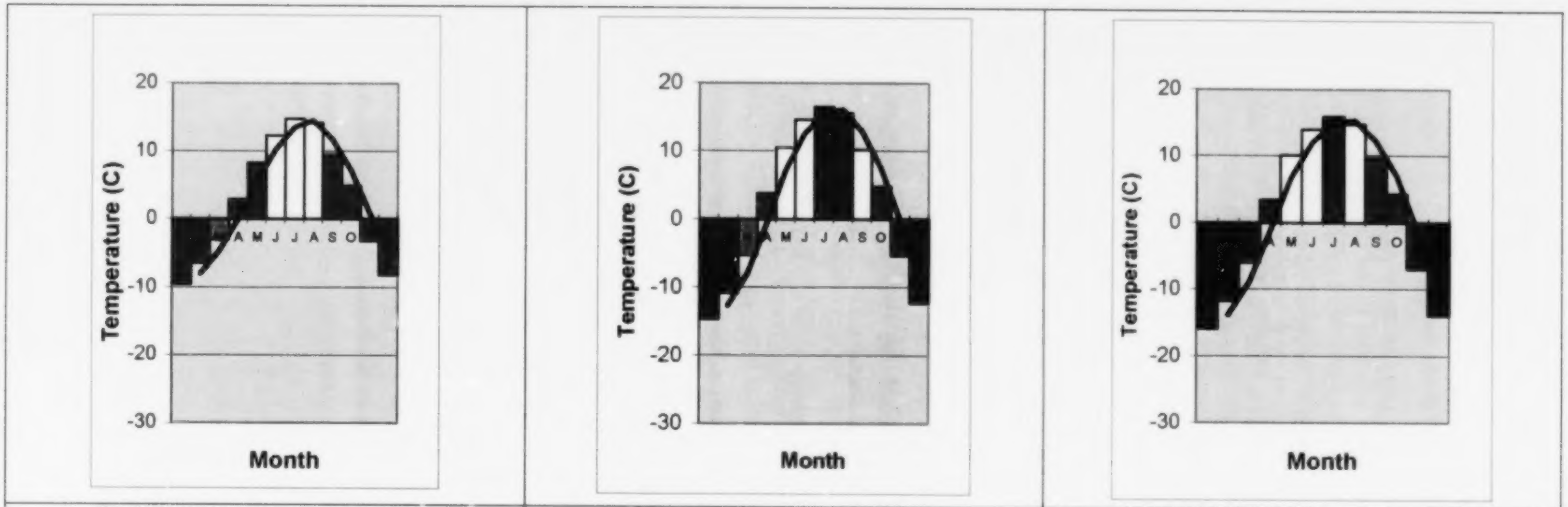
Notable Features

The most notable feature of the Parkland Natural Region is that it is unique to North America. It occurs mainly in the Prairie Provinces, with minor extensions into the northern United States.

Other features are as follow:

- The *Ribstone Plain*, which includes the *Wainwright Sand Dunes Ecological Reserve*, is a large complex of eolian dunes derived from reworked glaciofluvial deposits. The steeply sloped dunes can reach a height of 30 m, and active blowouts are common throughout. This creates a unique microtopography and adds to the diversity and complexity of the Central Parkland Natural Subregion.
- *Avifauna*: The numerous and very productive wetlands in the Central Parkland Natural Subregion are regarded as the "duck factory" of North America.
- *Other fauna*: The rare Nevada Buck-moth occurs on stabilized sand dunes with trembling aspen in the Edgerton area. This is the only place in Alberta where the species is known to occur (Schmidt 2004).
- *Flora*: About 100 (20 percent) of Alberta's rare vascular plant species occur in the Parkland Natural Region. Some, such as marsh gentian, are essentially restricted to the Parkland Natural Region but most are also found in the adjacent Grasslands, Boreal and Foothills Natural Regions (Kershaw et al. 2001). The Peace River Parkland Subregion and its northern outliers contain many species otherwise found primarily in the Grasslands Natural Region, including needle grasses and brittle prickly pear.

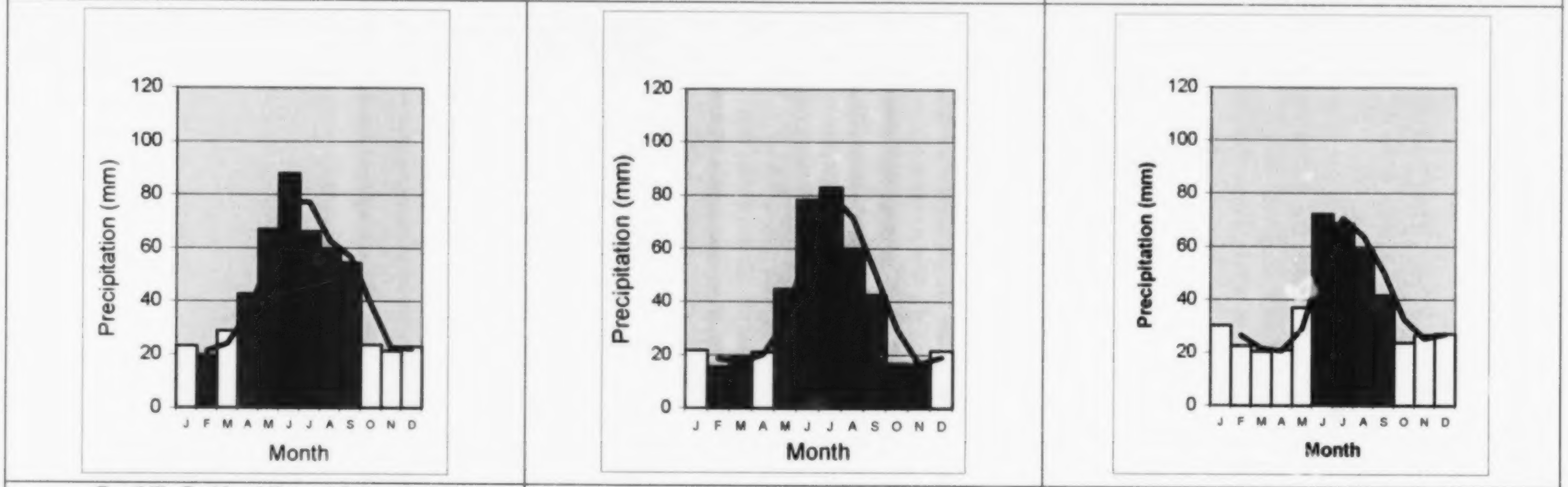
The wetlands of the Central Parkland Natural Subregion are called the "duck factory" of North America. (Photo: L. Allen)



Foothills Parkland Natural Subregion
Mean Monthly Temperature (MAT +3.0°C)

Central Parkland Natural Subregion
Mean Monthly Temperature (MAT +2.3°C)

Peace River Parkland Natural Subregion
Mean Monthly Temperature (MAT +1.5°C)



Foothills Parkland Natural Subregion
Mean Monthly Precipitation (MAP 517 mm)

Central Parkland Natural Subregion
Mean Monthly Precipitation (MAP 441 mm)

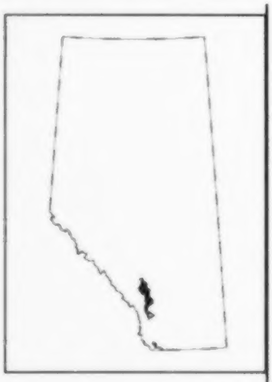
Peace River Parkland Natural Subregion
Mean Monthly Precipitation (MAP 450 mm)

Figure 4-4.1. Parkland Natural Region Climate Data Summaries. (*Refer to footnotes in Figures 3-8 and 3-11 for color scheme explanations. MAP= Mean Annual Precipitation, MAT= Mean Annual Temperature.*)

4.4.1 Foothills Parkland Natural Subregion

Theme

Rolling to hilly native grasslands on southerly slopes, aspen woodlands or willow shrublands in low-lying areas or on northerly slopes, and hay lands on undulating to rolling terrain define the Foothills Parkland Natural Subregion.



Overview (Photo: W. Pettapiece)

Total area: 3921 km² (6% of Parkland Natural Region).

Average elevation: 1250 m (range 1025-1525 m).

Key Features

- Cooler summers and shorter growing seasons, but warmer winters and more precipitation than other parkland Natural Subregions.
- Black Chernozems and Dark Gray Chernozems are typical; drier sites support mountain rough fescue–bluebunch fescue grasslands, and aspen forests or willow shrublands occur on moister sites.
- Shorter growing seasons result in less cultivation and more native vegetation than in the other two parkland Natural Subregions.

Snowberry is a common understory species in the woodlands. (Photo: L. Allen)

General Description

The Foothills Parkland Natural Subregion occupies a discontinuous belt along the foothills, ranging from about 5 to 50 km wide. It consists of two distinct units. The southern unit extends from the Alberta–Montana border north to the town of Pecten. The northern unit extends from approximately Willow Creek to about 50 km north of Calgary. In both units, marked changes in elevation create correspondingly rapid climate changes, and the Natural Subregion is narrowest in these places. Adjacent Natural Subregions are the Central Parkland and Lower Foothills to the north, the Foothills Fescue to the east, and the Montane to the west.

This is the highest parkland Natural Subregion, and elevations range from 1025 m north of Calgary to about 1400 m in the Porcupine Hills. Rolling to hilly landscapes are typical. Grasslands similar to those in the Foothills Fescue Natural Subregion occur on dry sites, and aspen stands like those in the Montane Natural Subregion occur on moister, cooler northerly aspects and in seepage areas. In the northern unit of the Foothills Parkland Natural Subregion, moist willow groves dominated by beaked willow and with a significant tall herb component are a distinguishing feature.

Black Chernozems are the dominant soils under grasslands, reflecting relatively high organic matter incorporation. Dark Gray Chernozems occur under forest cover. Open water and wetlands are uncommon. Because of relatively short growing seasons and correspondingly less intensive cultivation, the Foothills Parkland Natural Subregion has the highest proportional area remaining in native vegetation of the three parkland Natural Subregions.

Climate

The Foothills Parkland Natural Subregion has the highest precipitation, warmest winters, and shortest, coolest growing season of any of the parkland Natural Subregions. Proximity to the mountains and a greater incidence of Chinooks is responsible for these characteristics.

This Natural Subregion is climatically more similar to the Foothills Fescue and Montane Natural Subregions than it is to the other parkland Natural Subregions. The month of maximum precipitation is June, but May and July are also rainy months. The relatively short growing season restricts till cropping activities, and much of the area either produces hay crops or is under native cover.

Figure 4-4.1 provides a comparison of temperature and precipitation patterns between parkland Natural Subregions, and Table 3-2 gives annual and seasonal climate statistics.

Vegetation

The Foothills Parkland Natural Subregion is floristically similar to the adjacent Foothills Fescue and Montane Natural Subregions. The definition of reference vegetation is not straightforward, however. Site conditions that are conventionally termed "average" (moderately moist, medium textured soils) are not as common as dry sites occurring on south and west slopes, or moist sites occurring on northerly slopes near slope bases where seepage occurs, or in poorly drained low-lying areas. Accordingly, three characteristic communities that are associated with these more commonly occurring conditions are described within the Foothills Parkland Natural Subregion.

Species composition is influenced by latitude and Cordilleran influences. Some species become less common in the northern part of the Foothills Parkland Natural Subregion, such as bluebunch fescue, lupines and oat grasses. The majority of species with a southwestern distribution do not occur north of the Porcupine Hills. Species with a northern distribution that commonly occur in the Central Parkland Natural Subregion, such as beaked hazelnut, bunchberry, wild lily-of-the-valley and wild sarsaparilla, are absent from the Foothills Parkland Natural Subregion.

Foothills Parkland Natural Subregion upland vegetation has been described in general terms by Strong and Leggat (1992) and Achuff (1994), and the work by Adams et al. (2003) on the adjacent Foothills Fescue Natural Subregion is relevant to grasslands. The following summary and Figure 4-3.5 is a synthesis of these interpretations.

The driest south- and west-facing slopes are vegetated by mountain rough fescue–bluebunch fescue–needle-and-thread communities on well to rapidly drained Black Chernozems. Characteristic sites on somewhat moister southerly slopes are typically vegetated by herb-rich mountain rough fescue–bluebunch fescue grasslands in the southern unit of the Natural Subregion, and by similarly diverse mountain rough fescue–Parry oatgrass grasslands in the northern unit.

Characteristic sites on moist, moderately well drained northerly slopes, seepage zones or low areas support aspen forests with understories of snowberry, silverberry, white meadowsweet, prickly rose, saskatoon and a diverse array of herbs on well to imperfectly drained Black and Dark Gray Chernozems. Balsam poplar also occurs on moister sites, and white spruce or Douglas fir are occasional. A distinctive characteristic of woodlands in the southern part of the Foothills Parkland Natural Subregion is the springtime display of glacier lilies that bloom in early to mid-May.

The third characteristic community type is a willow groveland dominated by a dense beaked willow tall shrub canopy on moderately to imperfectly drained sites, usually on fine textured glaciolacustrine materials from the western slopes of the Porcupine Hills north to the Madden area. Typical understory associates are wild red raspberry, wild white geranium and other forbs. Moist Black Chernozems are typical soils.

Willow groveland is characteristic in areas of the Foothills Parkland. (Photo: L. Allen)

Along rivers, balsam poplar, plains cottonwood and aspen stands with shrubby understories occur on the valley floor and on northerly or easterly valley walls. Willow, sedge and tufted hair grass communities occur on loamy Humic Gleysols in poorly drained depressions and along rivers.

Geology and Geomorphology

The rolling to hilly landscapes of the Foothills Parkland Natural Subregion occur along the boundary of the Southern Alberta Uplands and the Foothills, and are heavily dissected by small intermittent streams. Tertiary and Upper Cretaceous formations composed of non-marine sandstones, mudstones and shales underlie moderately fine, weakly calcareous till that is often less than 2 m thick on steeper slopes. Ice-contact glaciolacustrine sediments occur across about 20 percent of the Natural Subregion, mainly in lower valley positions.

Appendix 4 summarizes the proportional occurrence of landscape elements and parent materials in the Foothills Parkland Natural Subregion.

Water and Wetlands

There is less than 1 percent open water in the Foothills Parkland Natural Subregion. The Bow River is the largest watercourse, and the very few lakes that do occur are all small. Wetlands are uncommon, accounting for about 4 percent of the total area, but seepage frequently occurs on lower slope positions.

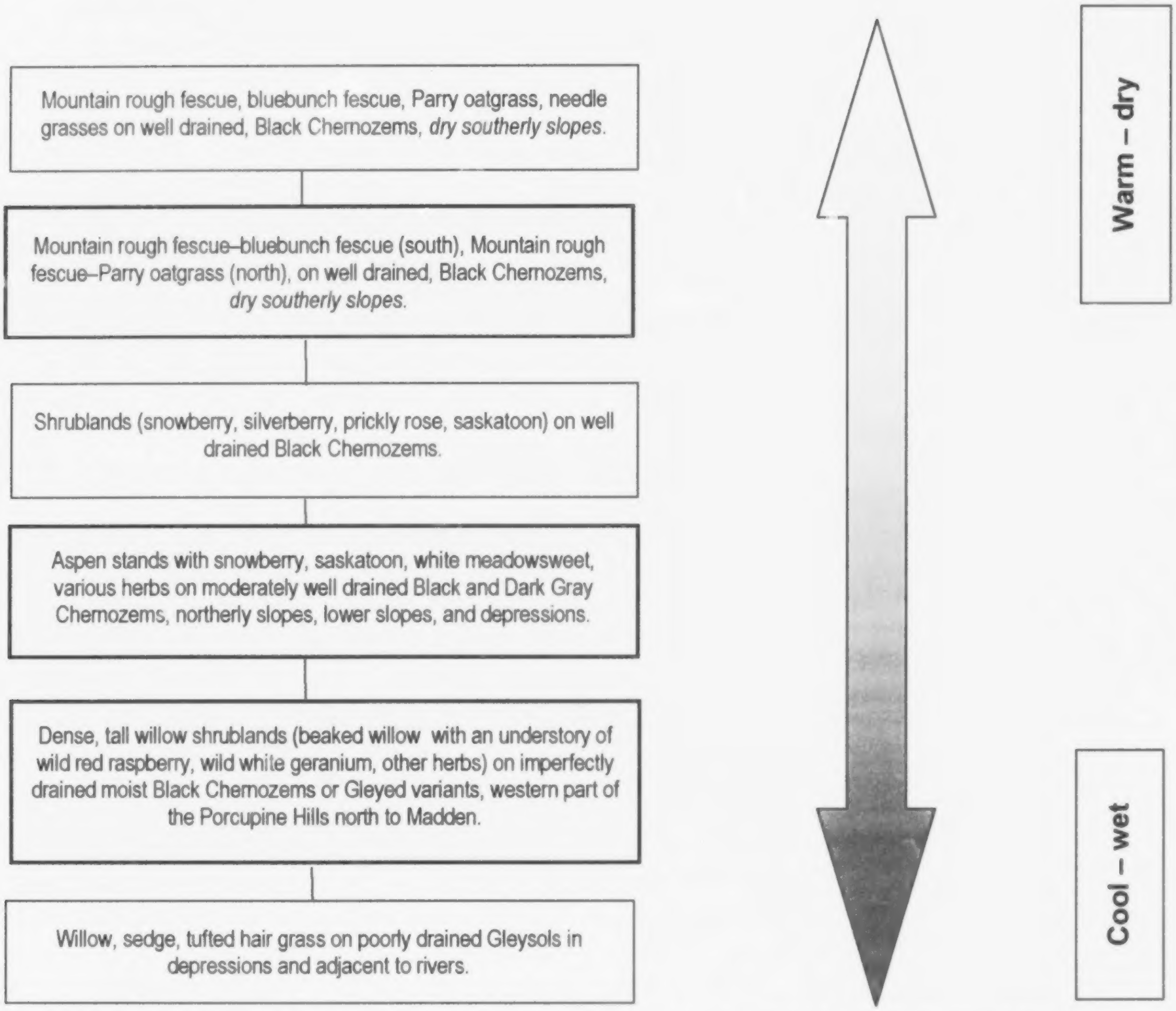
Soils

Deep Orthic Black Chernozems with surface humus horizons at least 15 cm thick are the most common soil types, and are associated with grassland and open woodland vegetation. Orthic Dark Gray Chernozemic soils are typically associated with forested areas. Seepage areas on lower slope positions and depressions support willow shrublands. Because the water is usually well oxygenated, the soils are classed as moist Chernozems rather than Gleysols. Orthic Gleysols occur in the wettest, most poorly drained areas. Appendix 6 summarizes the proportional occurrence of soil types in the Foothills Parkland Natural Subregion.

Land Uses

Short, cool summers at higher elevations in the Foothills Parkland Natural Subregion are not suitable for intensive agriculture; hay or feed grains are the main crops. Over 60 percent of the Natural Subregion is used for native or improved rangeland. Oil and gas exploration and development is significant. The Porcupine Hills are a popular hunting and camping destination.

Herb-rich mountain rough fescue. (Photo: L. Allen)



Mountain rough fescue, bluebunch fescue, Parry oatgrass, needle grasses on well drained, Black Chernozems, *dry southerly slopes*.

Mountain rough fescue–bluebunch fescue (south), Mountain rough fescue–Parry oatgrass (north), on well drained, Black Chernozems, *dry southerly slopes*.

Shrublands (snowberry, silverberry, prickly rose, saskatoon) on well drained Black Chernozems.

Aspen stands with snowberry, saskatoon, white meadowsweet, various herbs on moderately well drained Black and Dark Gray Chernozems, northerly slopes, lower slopes, and depressions.

Dense, tall willow shrublands (beaked willow with an understory of wild red raspberry, wild white geranium, other herbs) on imperfectly drained moist Black Chernozems or Gleyed variants, western part of the Porcupine Hills north to Madden.

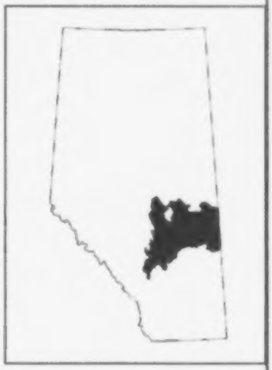
Willow, sedge, tufted hair grass on poorly drained Gleysols in depressions and adjacent to rivers.

Figure 4-4.2. Common ecosystems arranged along environmental gradient, Foothills Parkland Natural Subregion. (*Characteristic communities are in yellow-shaded boxes.*)

4.4.2 Central Parkland Natural Subregion

Theme

The Central Parkland Natural Subregion occupies a broad, intensively cultivated and heavily populated fertile crescent in central Alberta. It lies between the cold, snowy northern forests and the warm, dry southern prairies, sharing the climatic and vegetation characteristics of both.



Overview (Photo: L. Allen)

Total area: 53,706 km² (88% of Parkland Natural Region).

Average elevation: 750 m (range 500-1250 m).

Key Features

- Mostly cultivated with mosaic of aspen and prairie vegetation on remnant native parkland areas, usually associated with hummocky till or eolian materials.
- Temperature, precipitation and growing season characteristics are intermediate between the dry, warm grasslands to the south and the cooler, moister boreal forests to the west and north.
- Black Chernozems, some Dark Gray Chernozems, significant occurrences of Solonetzic soils.

Prickly rose is a common sight in the Central Parkland. (Photo: L. Allen)

General Description

The Central Parkland Natural Subregion includes over 50,000 km^2, much of it under cultivation. It includes all or parts of Alberta's three largest cities, and arches north from Calgary through Edmonton and east to the Alberta–Saskatchewan border. It meets the Dry Mixedwood Natural Subregion to the west and north, and the Foothills Fescue, Foothills Parkland and Northern Fescue Natural Subregions to the south. Elevations range from 500 m near the Alberta–Saskatchewan border to 1250 m near Calgary.

Undulating till plains and hummocky uplands are the dominant landforms. Lacustrine and fluvial deposits are locally common in the northern and eastern parts of the Natural Subregion, and there are some significant eolian deposits. Almost all the area is cultivated, but a mosaic of aspen and prairie vegetation occupies remnant native parkland areas.

In the southern and eastern parts of the Natural Subregion, plains rough fescue prairie is the dominant vegetation, with clumps of aspen present but restricted to moist sites. In the northern and western parts, aspen forest is dominant and grasslands are restricted to drier areas. Black Chernozems usually occur under grasslands, and Dark Gray Chernozems and Luvisols usually occur under aspen forests.

Climate

The Central Parkland Natural Subregion has a climate intermediate between the Dry Mixedwood Natural Subregion to the north and west and the Northern Fescue Natural Subregion to the south. Monthly temperature variations are most similar to those of the Northern Fescue Natural Subregion, with slightly warmer winters and summers than the Dry Mixedwood Natural Subregion.

Monthly precipitation patterns are most similar to those of the Dry Mixedwood Natural Subregion, with a marked peak in July and significant rainfalls in June and August. The western third of the Central Parkland Natural Subregion receives more annual precipitation on average than the remainder of the area, possibly due to higher elevations and more intense summer rainfalls.

The Central Parkland Natural Subregion is highly productive for annual crops because summer precipitation is adequate, the growing season is sufficiently warm and long, and soils are suitable. Table 3-2 provides annual and seasonal climate statistics, and Figure 4-4.1 gives a comparison of the Central Parkland Natural Subregion with other parkland Subregions.

Vegetation

Estimates vary, but current information suggests that only about 5 percent of the Central Parkland Natural Subregion remains in native vegetation. The area has been intensively cultivated for over a century, and the few remaining contiguous areas of parkland vegetation occur on sites that are unsuitable for agriculture because of topography or soil constraints.

Much of the native vegetation occurring on extensive till plains within the Natural Subregion was replaced by croplands before it could be surveyed and catalogued. Consequently, the delineation of Central Parkland Natural Subregion boundaries depends heavily on soil maps.

The primary vegetation differences between the Central Parkland and Foothills Parkland Natural Subregions are the dominance of plains rough fescue in the Central Parkland and mountain rough fescue in the Foothills Parkland, and other diagnostic species as discussed previously in Part 4.4.1. For example, beaked hazelnut, bunchberry, wild lily-of-the-valley and wild sarsaparilla commonly occur in the Central Parkland Natural Subregion, but are absent from the Foothills Parkland Natural Subregion.

The remaining native communities indicate a marked change in vegetation from southeast to northwest in response to increasing moisture. Fescue prairies dotted with aspen groves occur in the driest areas to the south and east. Increased moisture in the central portions allows the development of true parkland, where roughly equal proportions of aspen forest and plains rough fescue grasslands occur. Higher precipitation to the north and west promotes closed aspen forests within which small grassland patches may occur.

Strong and Leggat (1992) suggest the Central Parkland Natural Subregion be subdivided into a southern grassland-dominated portion and a northern aspen-dominated portion in recognition of these climate-related changes. A similar scheme is presented below and in Figure 4-4.3.

Grassland communities described for the Central Parkland Natural Subregion are similar to those in the adjacent Northern Fescue Natural Subregion. Western porcupine grass, June grass, needle-and-thread, blue grama, dryland sedges and pasture sagewort occur in sparsely vegetated communities on dry, rapidly drained sandy Black and Dark Brown Chernozems or Regosols. Plains rough fescue, slender wheat grass and forb cover increase with better soil moisture conditions. Smooth brome invasion on moist, loamy soils is currently a threat to plains rough fescue communities.

Reference sites for the grassland-dominated southern portion, which are now very uncommon, occur on loamy, well drained Black Chernozems. On undisturbed sites, plains rough fescue strongly dominates in stands with few other species.

More commonly, on light to moderately grazed sites, plains rough fescue shares dominance with western porcupine grass, northern wheat grass, Hooker's oatgrass and a variety of perennial herbs (e.g., prairie crocus, prairie sagewort, wild blue flax, northern bedstraw, three-flowered avens). Dry sites in the northern part of the Natural Subregion may also be vegetated by jack pine–bearberry communities on sandy, rapidly drained Regosols and Brunisols; however, these are uncommon.

A variety of herbs such as prairie crocus are often part of the grass communities. (Photo: L. Allen)

Moderately well drained sites in somewhat moister locations often support shrub communities (buckbrush, silverberry, prickly rose, chokecherry and saskatoon) on Black Chernozems. Silverberry communities are often found adjacent to saline wetlands in the southern Central Parkland Natural Subregion.

In the southeastern parts of the Central Parkland Natural Subregion, aspen communities are restricted to imperfectly drained depressions on medium to fine textured Gleysolic soils, where moisture is sufficient to support tree growth throughout the growing season. Precipitation increases to the north and west; aspen communities on Dark Gray Chernozems and Dark Gray Luvisols become dominant and are considered the reference community type for the aspen-dominated portion of the Central Parkland Natural Region.

Aspen understories throughout the Natural Subregion can be quite variable depending on parent material and moisture, but typically include saskatoon, prickly rose, beaked hazelnut, and a variety of forbs and grasses. Species such as hay sedge and creeping juniper make up the understory of aspen stands on sandy, rapidly drained sites.

Balsam poplar is often present with aspen and white spruce on moist, rich sites with lush, diverse understories throughout the Natural Subregion. White spruce can occur in pure stands on moist sites where fire occurrence is infrequent, and are most commonly found on protected locations on coulee slopes.

Common cattail, sedge or bulrush marshes and willow shrublands are common on wet, poorly drained Gleysolic soils across the Central Parkland Natural Subregion. Treed fens with black and white spruce, common Labrador tea and feathermosses occur on poorly drained Gleysols or Organic soils in the aspen-dominated portion of the Natural Subregion, and particularly in the northwest section. Wheatley and Bentz (2002) present a summary of all published Central Parkland community types, and Thompson and Hansen (2003) present detailed descriptions of riparian community types.

Geology and Geomorphology

The Central Parkland Natural Subregion lies mainly within the Eastern Alberta Plains. At higher elevations to the southwest, it also includes a small part of the Western Alberta Plains. Non-marine Upper Cretaceous sandstone and mudstone formations with minor occurrences of marine shales underlie the eastern portion. Tertiary sandstones and mudstones underlie the western portion. The dominant landform is undulating glacial till plains, with about 30 percent as hummocky, rolling and undulating uplands.

Surficial materials are dominantly medium to moderately fine textured, moderately calcareous glacial till that may be a thin (less than 2 m) blanket over bedrock in some of the low-relief plains. In the eastern part of the Natural Subregion, about 15 percent of the area is covered by glaciolacustrine and glaciofluvial sediments occurring as inclusions within the till plains.

Appendix 4 summarizes the proportional occurrence of landscape elements and parent materials in the Central Parkland Natural Subregion.

Water and Wetlands

Many small waterbodies are scattered throughout the Central Parkland Natural Subregion, and account for about 2 percent of the area. The largest of these are Beaverhill, Gull, Buffalo and Sounding Lakes. Major watercourses include the Red Deer, Battle and North Saskatchewan Rivers.

Wetlands cover about 10 percent of the Central Parkland Natural Subregion, and are more common than in the Northern Fescue Natural Subregion because of the somewhat cooler and moister climate. Marshes, willow shrublands and seasonal ponds are typical wetland types in the southern part of the Natural Subregion, but treed fens with shallow organic soils also occur in the northwest.

Soils

Orthic Black Chernozems are typically associated with grasslands and open woodlands in the Central Parkland Natural Subregion. Solonetzic soils (Solodized Solonetz and Solod) occupy significant areas (about 15 percent) of the central low-relief plain, with a further 20 to 30 percent of soils having Solonetzic properties. Thickness of the dark surface humus layers ranges from 15 cm at the southern limits of the Natural Subregion, to about 30 cm along its northern limits.

Forested areas commonly have Orthic Dark Gray Chernozemic and Dark Gray Luvisolic soils. These soils are uncommon in the southern part of the Natural Subregion, but become increasingly common to the north and occur on about 30 percent of landscapes along the northern boundary.

Humic and Orthic Gleysols are the most common soil types associated with wetlands. Peaty subgroups are common along the Central Parkland–Dry Mixedwood Natural Subregion boundary.

Appendix 6 summarizes the proportional occurrence of soil types in the Central Parkland Natural Subregion.

Land Uses

The Central Parkland Natural Subregion is the most densely populated region in Alberta; Edmonton, Red Deer and Calgary all lie wholly or partly within it. This Natural Subregion is also the most productive agricultural region in Alberta. Cropland covers about 80 percent of the plains and about 65 percent of hummocky uplands; the remaining area is grazing land. Wheat, barley and canola are the dominant crops in the central and eastern portions with some specialty crops such as pulses and flax. At higher elevations in the southwestern part of the Natural Subregion, a shorter frost-free period limits crop production to cool-season barley and forages.

Conventional petroleum exploration and development activities occur throughout. Heavy oil, strip coal mining and gravel extraction activities occur locally.

One of the greatest threats to plains rough fescue appears to be the invasion of smooth brome. This is occurring primarily on moist sites with loamy soils. The degree of infestation varies depending on a number of factors including proximity to seed source, grazing regime, and any activity that creates bare soil.

Plains rough fescue grasslands, often with a variety of perennial herbs, are one component of the Central Parkland mosaic. (Photo: L. Allen)

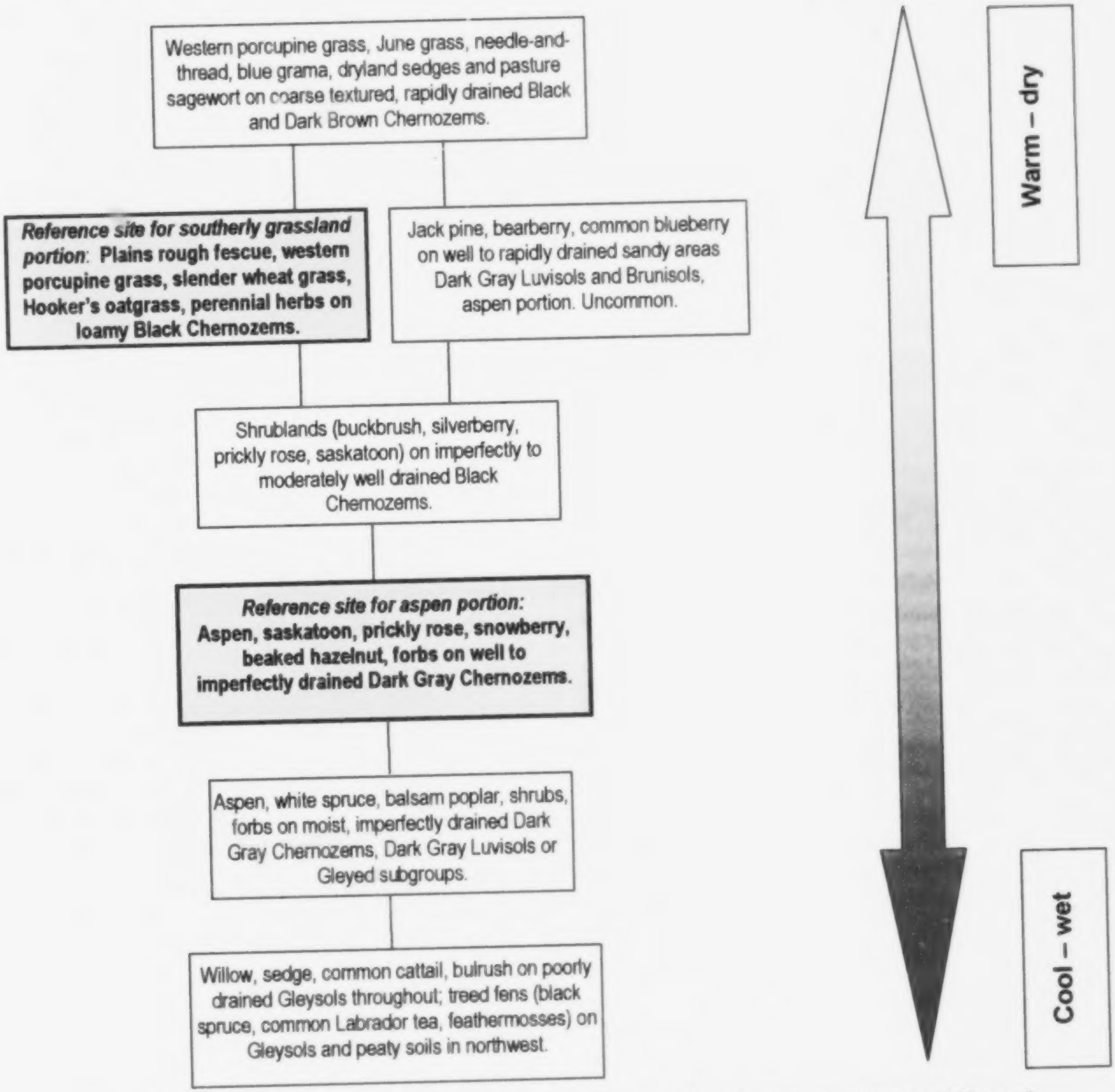
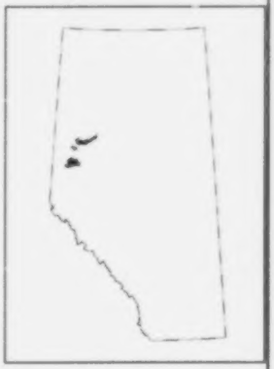

Western porcupine grass, June grass, needle-and-thread, blue grama, dryland sedges and pasture sagewort on coarse textured, rapidly drained Black and Dark Brown Chernozems.
Reference site for southerly grassland portion: **Plains rough fescue, western porcupine grass, slender wheat grass, Hooker's oatgrass, perennial herbs on loamy Black Chernozems.**
Jack pine, bearberry, common blueberry on well to rapidly drained sandy areas Dark Gray Luvisols and Brunisols, aspen portion. Uncommon.
Shrublands (buckbrush, silverberry, prickly rose, saskatoon) on imperfectly to moderately well drained Black Chernozems.
Reference site for aspen portion: **Aspen, saskatoon, prickly rose, snowberry, beaked hazelnut, forbs on well to imperfectly drained Dark Gray Chernozems.**
Aspen, white spruce, balsam poplar, shrubs, forbs on moist, imperfectly drained Dark Gray Chernozems, Dark Gray Luvisols or Gleyed subgroups.
Willow, sedge, common cattail, bulrush on poorly drained Gleysols throughout; treed fens (black spruce, common Labrador tea, feathermosses) on Gleysols and peaty soils in northwest.
Warm – dry
Cool – wet

Figure 4-4.3. Common ecosystems arranged along environmental gradient, Central Parkland Natural Subregion. (*Reference sites are in blue-shaded boxes in boldface type.*)

4.4.3 Peace River Parkland Natural Subregion

Theme

The Peace River Parkland Natural Subregion lies well north of the other Parkland Natural Subregions. It is defined by gently rolling plains and steep, south-facing grassy and forested slopes along the Peace River. It is the smallest Natural Subregion in Alberta.



Key Features

- Almost all uplands are cultivated.
- Black soils indicate the extent of pre-settlement grasslands.
- Upland forests of aspen and white spruce; dry grasslands and aspen forests on valley slopes.
- Slightly drier and warmer than the surrounding Dry Mixedwood Natural Subregion.
- Significant admixture of Solonetzic soils and Solonetzic subgroups of Chernozems on the plains.

Overview (Photo: W. Pettapiece)

Total area: 3120 km² (5% of Parkland Natural Region).
Average elevation: 625 m (range 300-800 m).

Saskatoon shrublands are common in the Peace River Parkland. (Photo: L. Allen)

General Description

The Peace River Parkland Natural Subregion is the smallest Natural Subregion in Alberta, and accounts for only 0.5 percent of the province's total area. It is mapped as three small sub-areas in northwestern Alberta.

The northernmost sub-area runs parallel to the Peace River from the town of Peace River to Dunvegan. It includes the south-facing, steep Peace River valley slopes and glaciolacustrine plains on the north side of the river to a distance of about 20 km back from the river break. The second sub-area includes a small level to gently undulating glaciolacustrine plain centered on Spirit River. The third and most southerly sub-area is an undulating to rolling glaciolacustrine plain adjacent to Grande Prairie.

There are other known areas of Parkland, but they are generally too small to map at the provincial scale. The Dry Mixedwood Natural Subregion surrounds all sub-areas.

Elevations range from 300 m along the Peace River near Peace River townsite, to 800 m in the Grande Prairie area. Almost all the upland plains have been cultivated. The remaining upland forested areas are mainly aspen stands on Dark Gray Chernozems or Luvisols.

Porcupine grass–California oat grass–sedge prairies occur with Solonetzic soils and are very uncommon. On the south-facing valley slopes, needle grass–June grass communities occur on the driest locations; aspen forests and dry shrublands occur on moister areas.

Because most of the area is cultivated, the Peace River Parkland Natural Subregion is defined by soil criteria. The core conditions for this Natural Subregion are defined by the occurrence of Chernozemic and Solonetzic soils; soil maps were used to delineate the current boundaries.

The Peace River Parkland was recognized by the first explorers to the area, who noted the occurrence of extensive tracts of "native prairie" in an otherwise forested landscape. Agricultural development started in the early 1900s, and little the original native prairie remains today.

Recognition of this as a distinctive landscape relies heavily on the written observations of the early explorers, and other historical and current evidence. For example, Hudson's Bay records show a disjunct population of pronghorn occurred in the Peace River area, up until about the 1850s (Ferguson 2003). Still present are disjunct populations of plants and insects, otherwise associated with the Grassland Natural Region. Taken together, these suggest an ecosystem distinct from the surrounding boreal landscapes.

Climate

The Peace River Parkland Natural Subregion is climatically similar to the Central Parkland Natural Subregion. However, there appear to be climatic variations within this Natural Subregion. Climatic models indicate a trend to fewer growing degree-days and higher mean annual precipitation for the southernmost sub-area (refer to the General Description for sub-area definitions).

This sub-area occurs at higher elevations and is closer to the Foothills Natural Region than the other two; possibly Cordilleran influences and the tendency for precipitation to increase and temperatures to decrease with elevation explain the growing season and precipitation trend.

Figure 4-4.1 provides a comparison of temperature and precipitation patterns between the Peace River Parkland Natural Subregion and other parkland Subregions, and Table 3-2 gives annual and seasonal climate statistics.

Vegetation

Past and present vegetation patterns in the Peace River Parkland Natural Subregion are of considerable interest. Prior to cultivation, extensive native prairies occurred around Grande Prairie and west of Peace River, with small outliers even farther north (Keg River, Paddle Prairie, Buffalo Prairie).

Wilkinson and Johnson (1983) examined historic records and soil distributions, and concluded the present-day remnant prairies are closely correlated to the distribution of Solonetzic soils, with fire and climate playing secondary roles. Most of the native vegetation was replaced by croplands before it could be studied and representative areas set aside. Thus, the delineation of Peace River Parkland Natural Subregion boundaries depends heavily on soil maps where Black Chernozemic and Solonetzic soil units define the core areas.

Western porcupine grass, June grass, sedges, and pasture sagewort are interspersed with bare mineral soil on steep, dry south-facing slopes of the Peace and Smoky Rivers. On less pronounced slopes where moisture is in greater supply, northern and slender wheat grasses are more abundant. Brittle prickly-pear and several grass species typical of more southerly areas occur with low cover. Regosols and Rego Brown Chernozems are typical.

Shallow gullies, depressions and lower slope positions on moderately dry south- to west-facing slopes provide sufficient moisture for the establishment of saskatoon, choke cherry and buckbrush shrublands. Aspen may also occur where moisture is sufficient. As well, jack pine stands develop on well to rapidly drained glaciofluvial and eolian deposits.

One community could be considered as a reference site for the Peace River Parkland Natural Subregion. The sedge–California oat grass–porcupine grass community occurs on fine textured, moderately well drained

Solonetzic Chernozems, but is quite uncommon. However, the soils that developed under this community are still present on cultivated lands and are dominant in this Natural Subregion.

Aspen forest communities with an understory of beaked willow, prickly rose, snowberry, bluejoint and a variety of forbs occur on well drained, fine textured Gray and Dark Gray Luvisols. These are the most common remaining native community types on the uplands, and may be considered characteristic sites.

Moist, rich sites on lower valley walls and on fluvial terraces along the Peace River support tall stands of balsam poplar, with understories dominated by red-osier dogwood and horsetail, on variable textured, well drained Regosolic soils. White spruce may occur as an associate.

In wet, poorly drained upland depressions, willow–sedge–bluejoint communities or black spruce–common Labrador tea–peat moss fens develop on Gleysols or Terric Mesisols.

Information for this synthesis was abstracted from Moss (1955), Wilkinson and Johnson (1983) and Downing et al. (1986).

Geology and Geomorphology

There are two distinct terrain types within the Peace River Parkland Natural Subregion: the gently undulating to rolling plains within the Rycroft and Grande Prairie Plains, and the steep, south-facing slopes of the Peace River Valley. Cretaceous marine shales underlie the plains north of the Peace River. Non-marine sandstones, mudstones and shales underlie areas south of the Peace River and in the Peace River Valley.

Surficial materials on the plains are predominantly weakly saline, weakly calcareous, fine textured glaciolacustrine sediments. Valley materials include variably textured colluvium on the slopes with alluvial deposits on the valley floor.

Appendix 4 summarizes the proportional occurrence of landscape elements and parent materials in the Peace River Parkland Natural Subregion.

Water and Wetlands

The Peace River, Bear Lake and a few other small water bodies and watercourses account for about 2 percent of the total area. Six percent of the area is occupied by wetlands, including willow fens, black spruce fens and seasonal ponds.

Soils

Soils on the upland plains are mainly Solonetzic intergrades of Dark Gray and Black Chernozems. There are significant inclusions of associated Solonetzic soils (mainly Solods) and both Dark Gray Luvisols and Orthic Gray Luvisols. Many of these fine textured soils show signs of surface gleying, and many are imperfectly drained.

Soils on Peace River valley slopes are a complex of Regosols, Brunisols and Rego Dark Brown Chernozems. Humic and Orthic Cumulic Regosols occur on fluvial terraces. Soils associated with wetlands are mainly Orthic and Humic Gleysols, often with Peaty phases. There are also inclusions of Terric Mesisols where the peat accumulation exceeds 40 cm. Appendix 6 summarizes the proportional occurrence of soil types in the Peace River Parkland Natural Subregion.

Land Uses

Agriculture is the major land use with about 70 percent of the area cultivated; canola, wheat and barley are the main crops. Petroleum exploration and development is extensive throughout this Natural Subregion.

Grassland of mixed species including porcupine grass on dryer slopes with shrublands and aspen woodlands in depressions. (Photo: J. Rintoul)

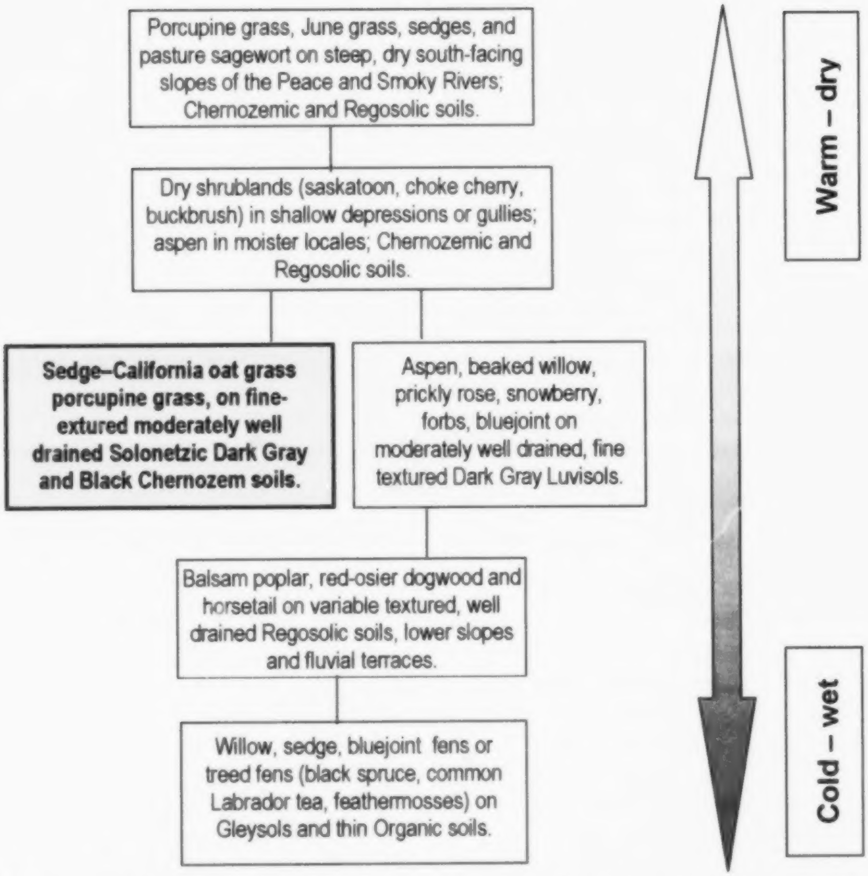
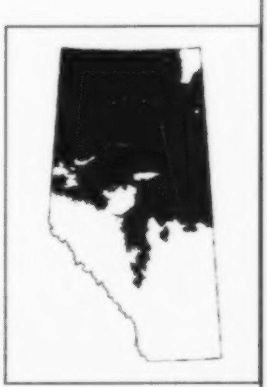

Porcupine grass, June grass, sedges, and pasture sagewort on steep, dry south-facing slopes of the Peace and Smoky Rivers; Chernozemic and Regosolic soils.
Dry shrublands (saskatoon, choke cherry, buckbrush) in shallow depressions or gullies; aspen in moister locales; Chernozemic and Regosolic soils.
Sedge–California oat grass porcupine grass, on fine-extured moderately well drained Solonetzic Dark Gray and Black Chernozem soils.
Aspen, beaked willow, prickly rose, snowberry, forbs, bluejoint on moderately well drained, fine textured Dark Gray Luvisols.
Balsam poplar, red-osier dogwood and horsetail on variable textured, well drained Regosolic soils, lower slopes and fluvial terraces.
Willow, sedge, bluejoint fens or treed fens (black spruce, common Labrador tea, feathermosses) on Gleysols and thin Organic soils.
Warm – dry
Cold – wet

Figure 4-4.4. Common ecosystems arranged along environmental gradient, Peace River Parkland Natural Subregion. (*Reference site is in blue-shaded box in boldface type. Characteristic site is in yellow-shaded box.*)

4.5 BOREAL FOREST NATURAL REGION

Theme

Short summers, long, cold winters and vast deciduous, mixedwood, and coniferous forests interspersed with extensive wetlands characterize the Boreal Forest Natural Region. This is Alberta's largest Natural Region; it occupies over half the Province and includes eight Natural Subregions.



- Total area: 381,046 km^2 (58% of province).

Boreal lakes and ponds provide habitat for the Common Loon. (Photo: D. Vujnovic)

General Description

The Boreal Forest Natural Region includes the Dry Mixedwood, Central Mixedwood, Lower Boreal Highlands, Upper Boreal Highlands, Athabasca Plain, Peace–Athabasca Delta, Northern Mixedwood, and Boreal Subarctic Natural Subregions. It occupies most of northern Alberta, and extends south almost to Calgary.

Elevations range from about 150 m in the Northern Mixedwood Natural Subregion near the Alberta–Northwest Territories border to over 1100 m in the Upper Boreal Highlands Natural Subregion near the Alberta–British Columbia border. Level to undulating till and lacustrine plains interspersed with extensive wetlands are the dominant landforms; hummocky landscapes, high-elevation plateaus and extensive dune fields also occur.

This Natural Region is vegetated by deciduous, mixedwood and coniferous forests. Cultivation is limited to those areas that have a sufficiently long growing season. Aspen and balsam poplar are the most common deciduous species; white spruce, black spruce and jack pine are the dominant conifers. Wetlands are dominantly black spruce, shrub or sedge fens. The dominant soils are Luvisols on uplands and Mesisols in wetlands.

The boundaries between some boreal Natural Subregions are relatively well defined, such as those defined by elevation criteria or slope breaks (e.g., the boundary between the Lower Boreal Highlands Natural Subregion and the adjacent Boreal Subarctic or Upper Boreal Highlands Natural Subregions). The boundaries for other boreal Natural Subregions are more gradual (e.g., the boundary between the Dry Mixedwood and Central Mixedwood Natural Subregions), and differences in vegetation and soils may not be evident for several kilometers on either side of the mapped boundary.

Climate

The Boreal Forest Natural Region is comparable to the Rocky Mountain Natural Region in terms of overall climatic variability. However, landscape changes across the Boreal Forest Natural Region are more gradual and produce less abrupt climatic differences between Natural Subregions, whereas the Rocky Mountain Natural Region is highly variable over short distances because of pronounced elevation changes.

There is nearly a 5°C difference in mean annual temperature between the warmest and most southerly Natural Subregion (Dry Mixedwood) and the coldest and most northerly Natural Subregion (Boreal Subarctic). The differences in degree-day accumulations and mean annual precipitation are almost as pronounced.

Summers are short, with only one or two months in which the average daily temperature exceeds 15°C. Winters are long and very cold, with average daily temperatures below -10°C for four months or more in most Natural Subregions, and below -20°C for two months or more in the most northerly Natural Subregions.

Precipitation follows a summer-high continental pattern, with peak rainfalls occurring in July and about 60 to 70 percent of the annual precipitation received between April and August. Climate statistics for the Boreal Forest Natural Region are summarized in Table 3-1. Figure 4-5.1 presents the annual temperature and precipitation characteristics for all eight Natural Subregions.

Vegetation

The Boreal Forest Natural Region is a mosaic of upland forests and extensive wetlands in low-lying areas. Both forest composition and the prevalence of wetlands changes from south to north moving through the Region. In the south, aspen forests are dominant, with white spruce occurring as scattered trees or small stands in moister locales. Wetlands are often shrubby or sedge fens and marshes. Cultivation is widespread where the growing season is sufficiently long to allow crop growth.

Vast forests interspersed with extensive wetlands characterize the region. (Photo: A. Landals)

Moving northward, mixed forests of aspen, balsam poplar and white spruce are the dominant upland vegetation, with a mix of treed fens, shrubby fens and sedge fens occupying a larger proportion of the landscape. Undulating plains and elevated plateaus in the far north are vegetated mainly by black spruce fens and bogs, shrubby fens and sedge meadows. Upland vegetation is associated with slightly higher landscape positions, and is a mixture of deciduous, mixedwood and coniferous forests.

Jack pine stands occur throughout the Natural Region on dry, well drained sandy soils and are extensive in some areas. Lodgepole pine or lodgepole pine-jack pine hybrids form pure or mixed stands with black spruce and deciduous species on the slopes and tops of northern highlands.

Topography, Geology, Soils and Hydrology

Level to gently undulating, fine textured lacustrine and till plains are the dominant landform in the Boreal Forest Natural Region. Micro-relief changes are very subtle, but even a 0.5 m difference in local elevation is enough to produce significant differences in moisture and a corresponding development of upland and wetland communities and their associated soils.

Highlands and hill systems occur throughout the Region, and are most pronounced in the northern part of the Region. Much of the area occurs within the Northern and Eastern Alberta Plains; the northern highlands are part of the Northern Alberta Upland. Cretaceous shales underlie much of the Region, but are deeply buried under glacial deposits and generally outcrop only along deep river valleys.

Luvisolic soils occur on well to imperfectly drained forested sites. Thick forest litter layers, a general lack of humus incorporation into the mineral soil layers, and leaching of clays from the topmost layer to a zone of accumulation below reflect cool boreal climates. Precipitation exceeds evaporation and promotes leaching, and biological activity is low, retarding the formation of mineral humus layers.

Brunisols are common on well to rapidly drained fluvial or eolian materials. Gleysols and Organic soils are associated with wetlands and poorly drained soils. Organic soils reflect the slow decomposition rates of cold boreal climates and the resulting accumulation of organic matter. Cryosols occur in the far north and at higher elevations where low solar energy inputs, short summers and thick insulating moss mats result in permafrost development.

The northern part of the Boreal Forest Natural Region drains into the Mackenzie Valley basin by way of the Peace, Athabasca and Slave Rivers. The southern part drains into the Saskatchewan River system through the North Saskatchewan River. Several large lakes and many small lakes occur within the Region. Wetlands are common throughout the Region, and are a dominant landscape feature in the far northern and central portions and on high-elevation plateaus.

Appendices 4 and 7 summarize the proportional occurrence of landscape elements, parent materials and soil types in the Boreal Forest Natural Region.

Wildlife Habitats and Populations

The Boreal Forest Natural Region includes wildlife species characteristic of the northern coniferous forests and wetlands that stretch across Canada. The geographic extent of this Natural Region and its varied climatic, topographic and vegetation characteristics have produced many habitats and associated wildlife assemblages. Wildlife diversity is highest in the south-central and eastern portions of the Natural Region. Harsher climates and lower habitat diversity in northern areas, such as the Boreal Subarctic Natural Subregion, contribute to a correspondingly less diverse wildlife community.

Sources of information for the following discussion include Vujnovic (2001) and Thomas and Carroll (2001), in addition to the general sources provided in the introduction to Part 4.

The same factors that affect wildlife community diversity also influence species composition. Species with a subarctic distribution, such as the Red-necked Phalarope, nest occasionally; others, such as the Red-throated Loon, nest regularly in suitable habitats in the Boreal Subarctic Natural Subregion but not elsewhere in Alberta.

Some species such, as Willow Ptarmigan, migrate south from the Northwest Territories to spend the winter in Alberta, then migrate again in the spring to breeding grounds further north. Other species with a primarily eastern boreal distribution, such as Yellow Rail, Sedge Wren, Great-crested Flycatcher, Chestnut-sided Warbler and Blackburnian Warbler, occur in the southeastern parts of the Natural Region.

Characteristic and widespread mammal species of forested areas include the red squirrel, snowshoe hare, southern red-backed vole, cinereous shrew, least chipmunk, deer mouse, black bear, moose and ermine. Other mammals such as the fisher, wolverine, river otter, Canada lynx and gray wolf are less common and are locally distributed. The American beaver is a very important inhabitant of this Natural Region. Some of the most productive pond, meadow and swamp habitats are the result of its activities. Woodland caribou (boreal ecotype) populations occur within suitable habitats across this Natural Region.

The Boreal Forest Natural Subregion has a rich and diverse avifauna. Deciduous-dominated forests throughout the Natural Region are habitat for the Least Flycatcher, House Wren, Ovenbird, Red-eyed and Warbling Vireos, Tennessee Warbler, Baltimore Oriole and Rose-breasted Grosbeak. Mixed coniferous-deciduous forests include the Yellow-bellied Sapsucker, Swainson's Thrush, Solitary Vireo, Magnolia Warbler and White-throated Sparrow. Pileated Woodpecker and Northern Goshawk are most frequently seen in old-growth deciduous and coniferous stands.

Coniferous forests support wide-ranging bird species such as Western Wood Pewee, Gray Jay, Red-breasted Nuthatch, Golden and Ruby-crowned Kinglets, Yellow-rumped Warbler, Pine Siskin, Red and White-winged Crossbills, Dark-eyed Junco and Boreal Chickadee. Three warbler species, the Bay-breasted, Cape May and Black-throated Green Warblers, are confined largely to mature conifer-dominated mixedwoods in the central and eastern sectors.

Balsam fir stands have a particularly diverse community of coniferous woodland birds, including the Blackburnian Warbler. Common avian residents of black spruce-dominated coniferous woodlands at higher elevations and latitudes include Gray Jay, Common Raven, Yellow-rumped Warbler, Blackpoll Warbler, Dark-eyed Junco and Chipping Sparrow.

The most species-rich habitats are mixedwoods and tall shrub communities associated with swamps, beaver ponds, streams and lakes. Some species, such as the Yellow and Black-and-white Warblers, American Redstart, Song Sparrow, Northern Waterthrush, Fox Sparrow and Philadelphia Vireo are mostly restricted to these sites. The Barred Owl is found occasionally in mature mixedwoods along lakeshores and in river valleys.

Fens are commonly inhabited by Greater and Lesser Yellowlegs, Solitary Sandpiper, Common Snipe, Palm Warbler, Rusty Blackbird, Lincoln's Sparrow and Sandhill Cranes. Black spruce bogs are home to Spruce Grouse, Ruby-crowned Kinglet, Gray Jay, Chipping Sparrow,and Dark-eyed Junco. Lincoln's Sparrow, Swamp Sparrow, wood and chorus frogs, muskrat and American beaver are found in marshes. Moose also use marshes.

Lakes and ponds provide habitat for the White-winged Scoter, Lesser Scaup, Bufflehead, Common Goldeneye, Mallard, American Wigeon, Spotted Sandpiper, Western Grebe, Great Blue Heron and Common Loon. Some islands in larger lakes serve as nesting areas for colonial birds such as the American White Pelican, Common Tern, California and Ring-billed Gulls. Osprey and Bald Eagle nest along and near lakeshores.

Colonies of Double-crested Cormorants and American White Pelicans are locally distributed, but a major part of their natural range in Alberta lies within the Boreal Forest Natural Region. The world's most northerly breeding colony of American White Pelicans is located on the Slave River Rapids near Fort Smith.

The boreal chorus frog and wood frog range throughout most of the area, but are less common in the north and west. Western toads occur mostly in the southwestern portion of the Natural Region, while Canadian toads are more common in the eastern part. The most northerly populations of red-sided garter snakes in Alberta occur along the Slave River.

Fish populations are species-rich, particularly in the southeast portion of the Boreal Forest Natural Region. Species include the arctic grayling, northern redbelly dace, Iowa darter, lake whitefish, burbot, walleye, goldeye, lake chub, longnose and white suckers, emerald and spottail shiners, slimy sculpin, ninespine stickleback, walleye, yellow perch and northern pike.

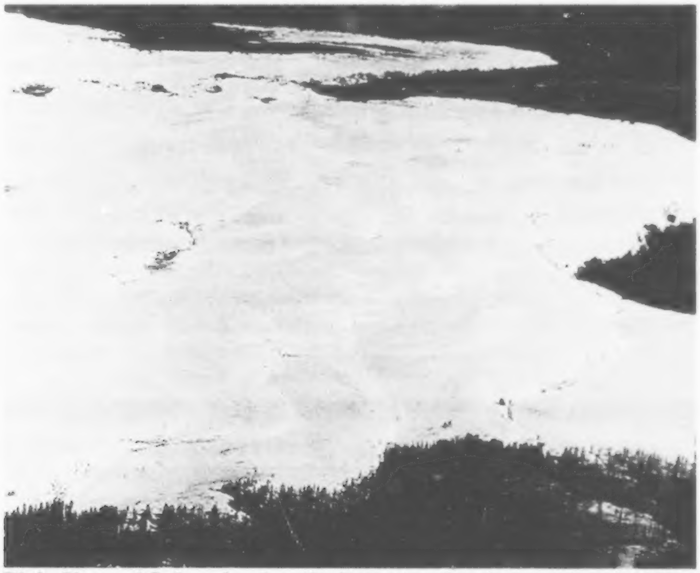
Notable Features

- *Peace-Athabasca Delta.* This is the largest boreal delta in the world. It is one of the most important nesting and staging areas for waterfowl in North America, and is an internationally important wetland as recognized under the Ramsar Convention. Whooping Cranes migrate through the area. The site also contains the largest undisturbed grass and sedge meadow complex in North America, and is prime wood bison range. The delta is an important fish spawning area for several species, including goldeye, walleye and northern pike. The round whitefish is known only from the Peace–Athabasca Delta.
- *Extensive dune and kame deposits.* The *Athabasca Plain Natural Subregion* has kame deposits that, at over 60 m in height, are among the largest in the world. An active dune system that is the largest in Alberta also occurs here.
- *Karst topography.* This exists along the Slave River in the Northern Mixedwood Natural Subregion.
- *Peat plateaus* (frozen Organic soils). These are found in the Boreal Subarctic and Northern Mixedwood Natural Subregions.
- *Whooping Cranes.* This species is listed as "Endangered" by COSEWIC and the Government of Alberta. Their only

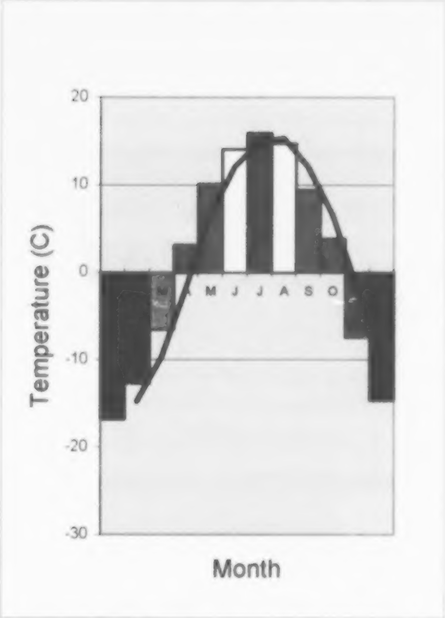
remaining nesting ground is Wood Buffalo National Park (WBNP) which lies within both Alberta and the Northwest Territories.

- *Woodland Caribou* (boreal ecotype). The woodland caribou is listed as "Threatened" by the Government and COSEWIC. This species depends on forested and other habitats in the Boreal Forest Natural Region. They are typically found in treed fens and bogs dominated by black spruce and larch, where there is an adequate supply of food, particularly lichens.
- *Wood Bison*. The wood bison (*Bison bison athabascae*) is a northern subspecies of the American bison, and occurs only in Canada. It is listed as "Threatened" by the Government of Alberta and COSEWIC.

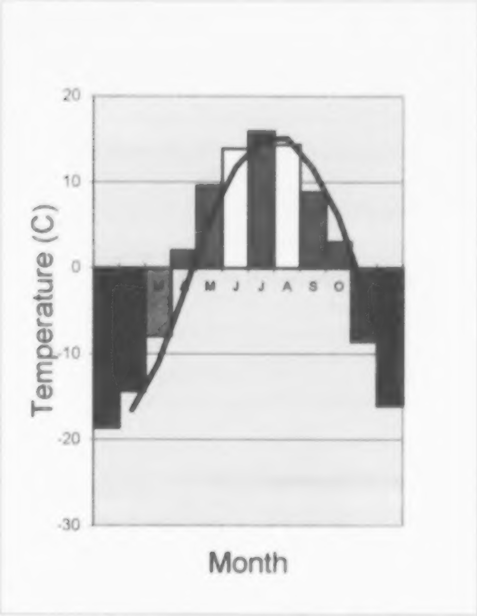
  The herd in Wood Buffalo National Park contains one of the largest free-roaming, self-regulating herds in existence. Other areas supporting wood bison within the Boreal Forest Natural Region include the Wabasca and Mikkwa Lowlands, Wentzel River area, Talbot Lake, and the Buffalo Head Hills. Wood bison have been reintroduced into some parts of Alberta, including the Assumption area (Hay–Zama complex) in the northwestern part of the province. (Mitchell and Gates 2002).
- *Flora*. About 110 (25 percent) of Alberta's rare vascular plant species occur in the Boreal Forest Natural Region. Of these, about 25 species are restricted to this Region in Alberta. Some species such as purple rattle have their southern limits in the Boreal Subarctic Natural Subregion. Others are associated with saline or alkaline soils, and a few with the kame and dune deposits of the Athabasca Plain, such as sand-dune chickweed (Kershaw et al. 2001).



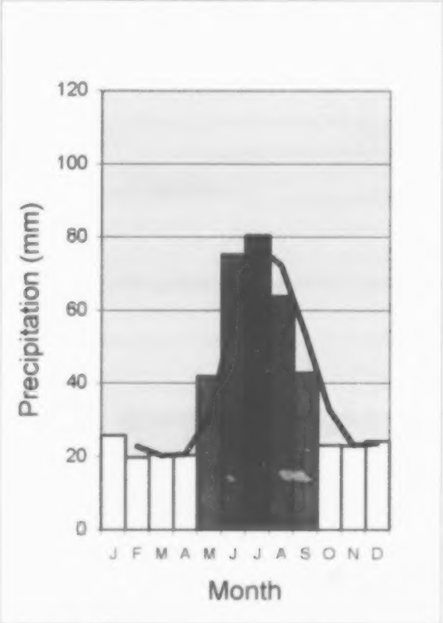
The Athabasca Plain Natural Subregion has the largest active dune system in Alberta. (Photo: L. Allen)



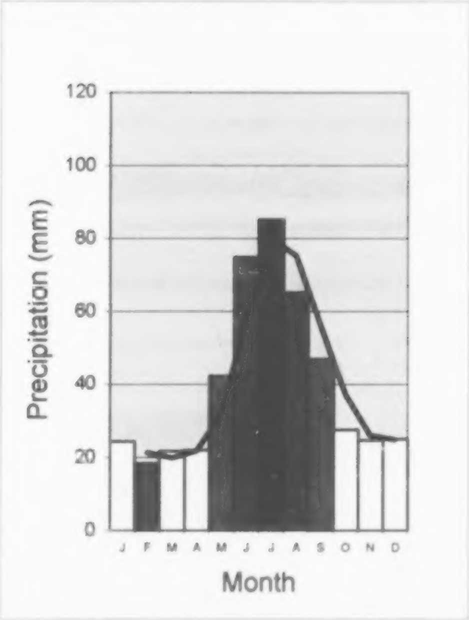
Dry Mixedwood Natural Subregion
Mean Monthly Temperature (MAT +1.1°C)



Central Mixedwood Natural Subregion
Mean Monthly Temperature (MAT +0.2°C)

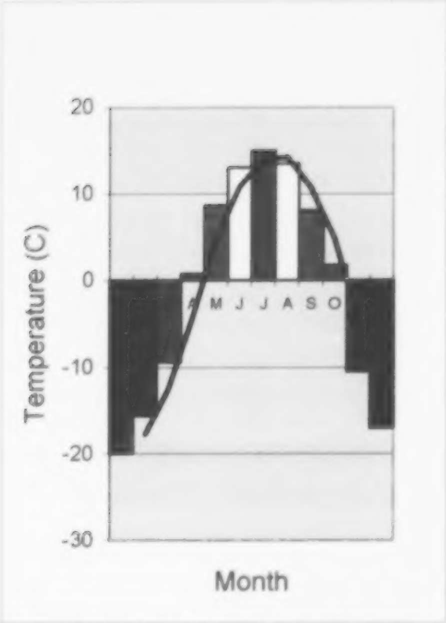


Dry Mixedwood Natural Subregion
Mean Monthly Precipitation (MAP 461 mm)

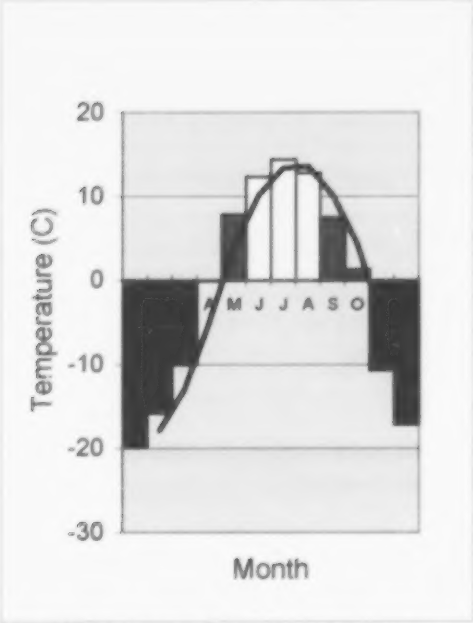


Central Mixedwood Natural Subregion
Mean Monthly Precipitation (MAP 478 mm)

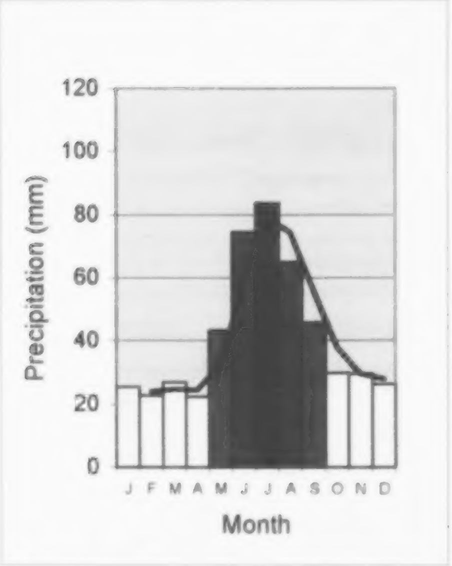
Figure 4-5.1. Boreal Forest Natural Region climate data summaries. (*Refer to footnotes in Figures 3-8 and 3-11 for color scheme explanations. MAP= Mean Annual Precipitation, MAT= Mean Annual Temperature.*)



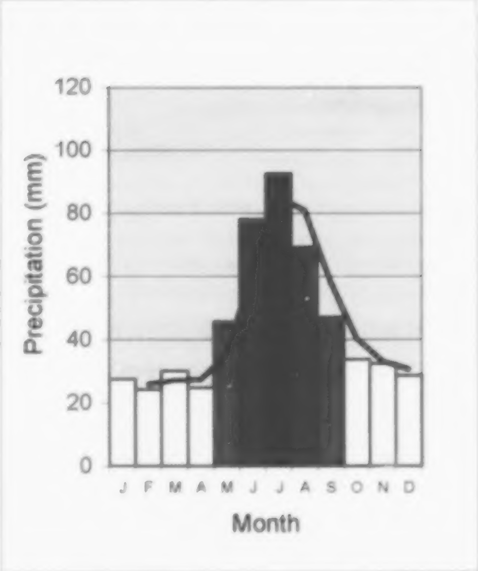
Lower Boreal Highlands Natural Subregion
Mean Monthly Temperature (MAT –1.0°C)



Upper Boreal Highlands Natural Subregion
Mean Monthly Temperature (MAT –1.5°C)

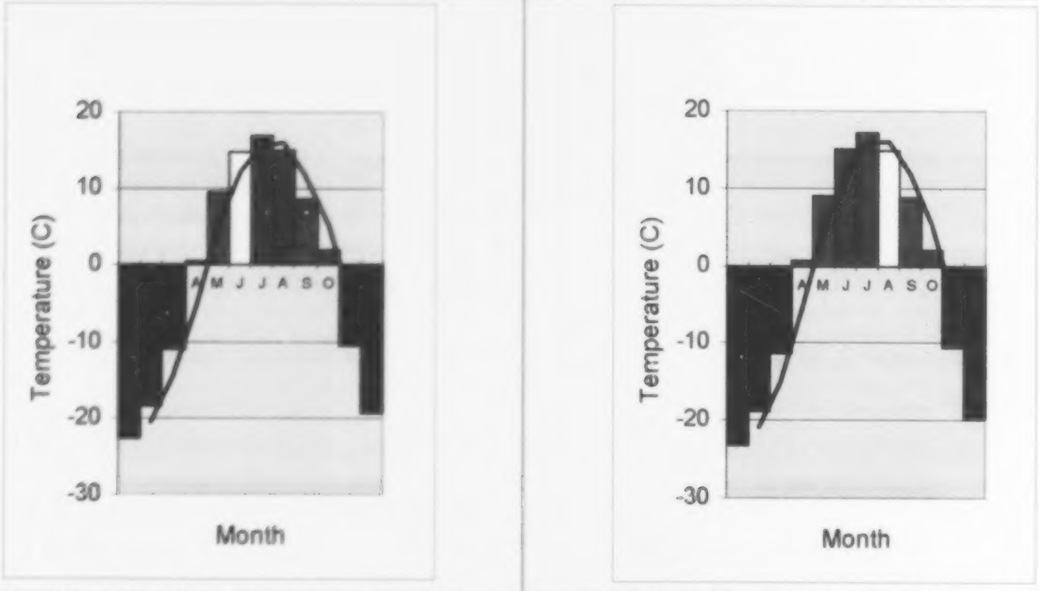


Lower Boreal Highlands Natural Subregion
Mean Monthly Precipitation (MAP 495 mm)



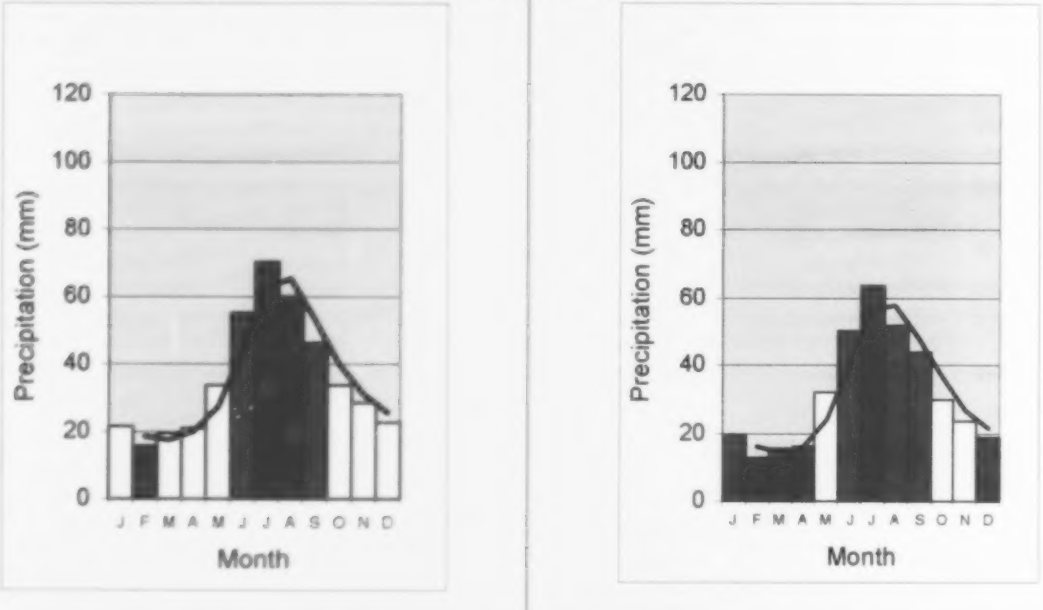
Upper Boreal Highlands Natural Subregion
Mean Monthly Precipitation (MAP 535 mm)

Figure 4-5.1 (continued). Boreal Forest Natural Region climate data summaries. *(Refer to footnotes in Figures 3-8 and 3-11 for color scheme explanations. MAP= Mean Annual Precipitation, MAT= Mean Annual Temperature.)*



Athabasca Plain Natural Subregion
Mean Monthly Temperature (MAT –1.2°C)

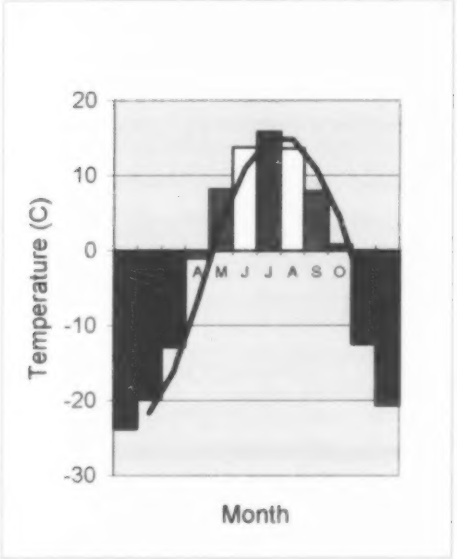
Peace-Athabasca Delta Natural Subregion
Mean Monthly Temperature (MAT –1.4°C)



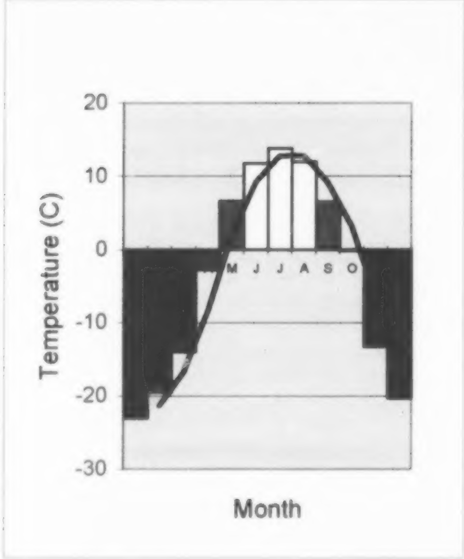
Athabasca Plain Natural Subregion
Mean Monthly Precipitation (MAP 428 mm)

Peace-Athabasca Delta Natural Subregion
Mean Monthly Precipitation (MAP 377 mm)

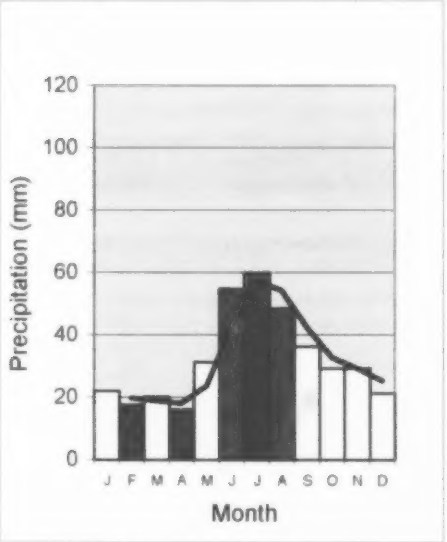
Figure 4-5.1 (continued). Boreal Forest Natural Region climate data summaries. *(Refer to footnotes in Figures 3-8 and 3-11 for color scheme explanations. MAP= Mean Annual Precipitation, MAT= Mean Annual Temperature.)*



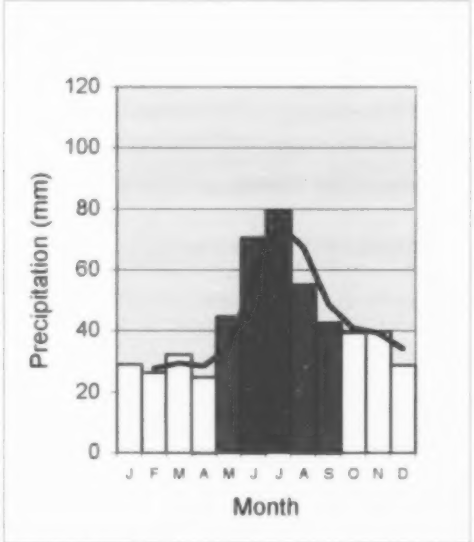
Northern Mixedwood Natural Subregion
Mean Monthly Temperature (MAT –2.5°C)



Boreal Subarctic Natural Subregion
Mean Monthly Temperature (MAT –3.6°C)



Northern Mixedwood Natural Subregion
Mean Monthly Precipitation (MAP 387 mm)



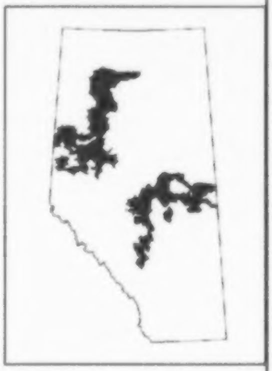
Boreal Subarctic Natural Subregion
Mean Monthly Precipitation (MAP 512 mm)

Figure 4-5.1 (concluded). Boreal Forest Natural Region climate data summaries. *(Refer to footnotes in Figures 3-8 and 3-11 for color scheme explanations. MAP= Mean Annual Precipitation, MAT= Mean Annual Temperature.)*

4.5.1 Dry Mixedwood Natural Subregion

Theme

Undulating plains, aspen-dominated forests and fens define the Dry Mixedwood Natural Subregion, the warmest boreal Natural Subregion.



Key Features

- Warmer summers and milder winters than most other Subregions in the Boreal Natural Region.
- Aspen stands with scattered white spruce interspersed with fens; cultivated areas on suitable soils throughout.
- Two climatically distinct areas within this Natural Subregion (Peace River and southern).
- Gray and Dark Gray Luvisols on uplands; Gleysols and Organic soils in wetlands.

Overview (Photo: D. Vujnovic)

Total area: 85,321 km² (22% of Boreal Forest Natural Region).

Average elevation: 600 m (range 225-1225 m).

Canada buffaloberry is common on lacustrine plains. (Photo: L. Allen)

General Description

The Dry Mixedwood Natural Subregion is the second largest Natural Subregion in Alberta and is mapped as three separate units.

- The largest, most northerly unit parallels the Peace River in northwestern Alberta from Grande Prairie to Fort Vermilion.
- The second unit lies to the south and occupies a crescent-shaped area in central Alberta between the Central Parkland and the Central Mixedwood Natural Subregions. The Lower Foothills Natural Subregion borders the Dry Mixedwood Natural Subregion in the extreme south.
- The third and smallest unit is associated with morainal uplands in the Cooking Lake area immediately east of Edmonton.

In the following discussion, the second and third units are considered together as a single southern unit. Elevations range from 200 m along the Peace River in the extreme northeast part of the Natural Subregion to 1225 m west of Sundre and adjacent to the Lower Foothills Natural Subregion.

Level to gently undulating glacial till or lacustrine plains are the dominant terrain type. Hummocky uplands are significant in the two southern mapped units. Gray Luvisols are the dominant soils on uplands; Gleysols and Organic soils are dominant in wetlands.

Aspen forests with mixed understories of rose, low-bush cranberry, beaked hazelnut and Canada buffaloberry are typical on uplands. Treed, shrubby or sedge-dominated fens occupy about 15 percent of the Natural Subregion. Jack pine stands occur on dry, well to rapidly drained glaciofluvial and eolian parent materials.

Bogs and fens become common in the Dry Mixedwood. (Photo: A. Landals)

Climate

The Dry Mixedwood Natural Subregion has the warmest summers and highest growing degree-day accumulations of any of the boreal Natural Subregions. It is the most southerly boreal Natural Subregion and receives more solar energy than other boreal Natural Subregions. Table 3-2 provides annual and seasonal climatic statistics.

Temperature and precipitation patterns are intermediate between those of the Central Parkland and the Central Mixedwood Natural Subregions (Figure 4-5.1). About 70 percent of the annual precipitation falls during the April to August period, with peak precipitation in June and July that is often associated with intense convective storm events.

The climate model indicates that both mean annual temperature and mean annual precipitation are higher in the southern part of this Subregion than in the Peace River area. Growing degree-days are highest in the Peace River area and west and north of Edmonton, and lowest east of Edmonton and along the foothills to the west.

The prevalence of early to mid-seral aspen forests in the Dry Mixedwood Natural Subregion, and the relative scarcity of white spruce compared to the adjacent Central Mixedwood Natural Subregion, might be in part due to a higher incidence of lightning-caused fires in the Dry Mixedwood.

Vegetation

The Dry Mixedwood Natural Subregion is characterized by aspen forests and cultivated landscapes, with fens commonly occurring in low-lying areas. Willoughby et al. (2004) synthesized the work of Beckingham and Archibald (1996), Thompson and Hansen (2003), Downing and Karpuk (1992), Brierley et al. (1985) and others. The following summary of native plant communities and the community diagram in Figure 4-5.2 were abstracted from Willoughby et al. (2004).

The driest sites are small areas along the steep, south- and west-facing upper slopes of the Peace, Smoky and Wapiti Rivers. They are very similar in species composition and environmental relationships to those of the Peace River Parkland, and Chernozemic soils also occur here.

Porcupine grass, June grass, sedges and pasture sagewort are interspersed with bare mineral soil on the steepest slopes. On less pronounced slopes where moisture is in better supply, northern and slender wheat grasses are more abundant, and Saskatoon–buckbrush shrublands occur in lower slope positions and in ravines or gullies.

Open jack pine stands with lichen understories occupy very dry, coarse textured glaciofluvial or eolian deposits. On coarse textured deposits where the water supply is somewhat better, jack pine, aspen and white spruce occur in pure or mixed stands. Understories include bearberry, common blueberry, green alder, prickly rose, wild lily-of-the-valley and hairy wild rye. Soils are typically Brunisols or weakly developed Gray Luvisols.

There are two reference community types for the Dry Boreal Mixedwood Natural Subregion, both occurring on sites judged to be of average moisture and nutrient status.

1. The reference type for the warmer southern units is aspen with understories of beaked hazelnut, prickly rose, wild sarsaparilla, cream colored vetchling, purple peavine, and bluejoint. Soils are typically medium to fine textured Gray and Dark Gray Luvisols.
2. In the Peace River area, reference aspen stands have understories of low bush cranberry, rose, Canada buffaloberry, hairy wild rye and bunchberry, and occur on fine textured Gray Luvisols and gleyed subgroups. Beaked hazelnut occurs, but is mostly restricted to coarse textured deposits within the Peace River valley.

Purple peavine. (Photo: D. Vujnovic)

On moist, rich sites, balsam poplar, aspen and white spruce occur as pure or mixed stands. Understories contain red-osier dogwood, prickly rose, and a diverse array of herbaceous species in deciduous and mixedwood stands, or a carpet of feathermosses and horsetails in coniferous stands. Soil textures are variable, and soils are Luvisols or Gleysols.

Wet, poorly drained sites support a variety of bog and fen communities. The composition and structure of these communities depends on water levels and nutrient status. Treed and shrubby fens are most common, while sedge fens and bogs are minor components. Gleysols and Organic soils are associated with these communities.

Red-osier dogwood is often part of the diverse understory on rich sites. (Photo: L. Allen)

Geology and Geomorphology

There are two geologically distinct areas in the Dry Mixedwood Natural Subregion:

- the undulating plains and somewhat hummocky uplands in central Alberta, and
- the level to gently rolling plains of the northerly Peace River and Vermilion Lowlands.

Bedrock formations underlying the central Alberta unit include Upper Cretaceous shale, sandstone and siltstone formations. The Peace area is underlain mainly by Upper Cretaceous sandstones and shales in the south and shales and siltstones in the north.

Surficial materials of the Peace River and central Alberta areas also differ. The two map units in central Alberta are dominated by a moderately fine textured, moderately calcareous glacial till. There is a significant component (10%) of glaciofluvial sands and organic deposits but only minor inclusions of glaciolacustrine materials.

In contrast, the Peace River map unit is predominantly fine textured glaciolacustrine and "lacustro-till" materials with about 15 percent glaciofluvial and eolian sands, about 10 percent organic deposits and very little glacial till. Organic deposits are not evenly distributed and may occupy up to 50 percent of some dune areas.

Appendix 4 summarizes the proportional occurrence of landscape elements and parent materials in the Dry Mixedwood Parkland Natural Subregion.

Water and Wetlands

Water covers about 3 percent of the Dry Mixedwood Natural Subregion, not including Lesser Slave Lake. Major rivers flowing north to the Mackenzie drainage include the Peace, Smoky and Athabasca Rivers. The North Saskatchewan River flows east to the Saskatchewan River drainage. There are also many small, shallow lakes. About 15 percent of the Natural Subregion is covered by wetlands, with organic accumulations underlying 10 percent and shallow peats or wet mineral soils underlying the remaining 5 percent.

Soils

Typical soils for the Dry Mixedwood Natural Subregion are Orthic Gray Luvisols under moderately well drained aspen forests. Significant areas of Dark Gray Luvisols are dominant, particularly in cultivated areas. Solonetzic soils and Solonetzic intergrades occupy sizeable areas in the Peace River portion, reflecting the slightly saline, fine textured parent materials.

Imperfect or restricted drainage is particularly common in the heavy clay soils of the Peace River Lowlands, and Gleysols or Gleyed Gray Luvisols are locally common. Brunisols and weakly developed Gray Luvisols occur on sandy glaciofluvial or eolian deposits.

Organic soils underlying wetlands are usually Terric Mesisols, while Fibric Mesisols are associated with poor fens and bogs. Peaty and Orthic Gleysols are also common wetland soils, particularly on level to gently undulating landforms.

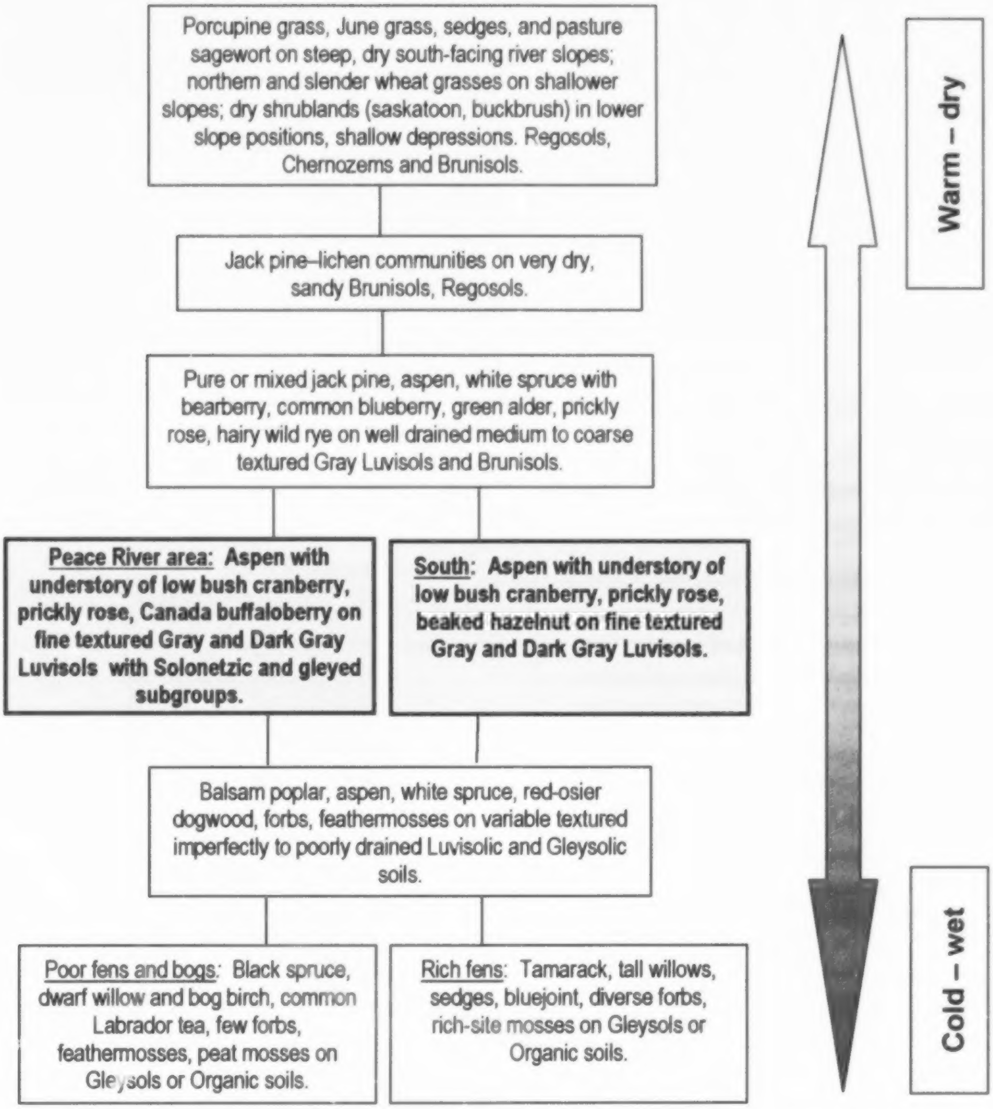
Appendix 7 summarizes the proportional occurrence of soil types in the Dry Mixedwood Natural Subregion.

Land Uses

Slightly over 50 percent of both the Peace River and central Alberta portions of the Dry Mixedwood Natural Subregion have been cultivated. The central Alberta portion has 40 to 70 percent of the cultivated area in barley and forage crops. The Peace River portion is highly variable in terms of total cultivated area depending on location, and a greater variety of crops are grown (oilseeds, wheat and forage seed production, barley and forages).

Significant aspen harvesting occurs throughout the Natural Subregion for pulp and paper production, along with incidental conifer production. Oil and gas activity is also a major land use with heavy oil in the Cold Lake and Peace River areas, and conventional oil and gas production in the west. Pit mining for thermal coal occurs in the Wabamun Lake area. Hunting and fishing are popular activities throughout the area.

Aspen with an understory of beaked hazelnut.
(Photo: L. Allen)


Porcupine grass, June grass, sedges, and pasture sagewort on steep, dry south-facing river slopes; northern and slender wheat grasses on shallower slopes; dry shrublands (saskatoon, buckbrush) in lower slope positions, shallow depressions. Regosols, Chernozems and Brunisols.

Jack pine–lichen communities on very dry, sandy Brunisols, Regosols.

Pure or mixed jack pine, aspen, white spruce with bearberry, common blueberry, green alder, prickly rose, hairy wild rye on well drained medium to coarse textured Gray Luvisols and Brunisols.

Peace River area: Aspen with understory of low bush cranberry, prickly rose, Canada buffaloberry on fine textured Gray and Dark Gray Luvisols with Solonetzic and gleyed subgroups.

South: Aspen with understory of low bush cranberry, prickly rose, beaked hazelnut on fine textured Gray and Dark Gray Luvisols.

Balsam poplar, aspen, white spruce, red-osier dogwood, forbs, feathermosses on variable textured imperfectly to poorly drained Luvisolic and Gleysolic soils.

Poor fens and bogs: Black spruce, dwarf willow and bog birch, common Labrador tea, few forbs, feathermosses, peat mosses on Gleysols or Organic soils.

Rich fens: Tamarack, tall willows, sedges, bluejoint, diverse forbs, rich-site mosses on Gleysols or Organic soils.

Figure 4-5.2. Common ecosystems arranged along environmental gradient, Dry Mixedwood Natural Subregion. (*Reference sites are in blue-shaded boxes in boldface type.*)

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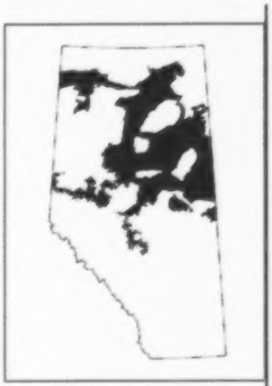
4.5.2 Central Mixedwood Natural Subregion

Theme

Vast expanses of upland forests and wetlands on level to gently undulating plains, short, warm summers and long, cold winters define the Central Mixedwood Natural Subregion. This is the largest Natural Subregion in Alberta.



Overview (Photo: A. Landals)

Total area: 167,856 km² (44% of Boreal Forest Natural Region).

Average elevation: 525 m (range 200-1050 m.

Bluejoint can become dominant after disturbance.
(Photo: L. Allen)

Key Features

- A mosaic of aspen, mixedwood and white spruce forests on uplands, with extensive areas of mainly treed fens in central areas and jack pine stands on coarser materials to the east.
- On average, slightly cooler and moister than the Dry Mixedwood Natural Subregion, but its extent results in north-to-south variability.
- Gray Luvisolic soils on medium to fine textured upland sites, with Brunisols on sands and Organic soils in poorly drained lowlands.

General Description

The Central Mixedwood Natural Subregion occupies 25 percent of Alberta, stretching south from the Caribou Mountains and Cameron Hills to just north of Red Deer, and spanning the province from the British Columbia to Saskatchewan borders. It shares boundaries with most of the other boreal Natural Subregions, as well as with the Lower Foothills Natural Subregion.

Elevations range from 200 m along the Peace River in the northeast to 1050 m in the extreme south. Gently undulating plains with some hummocky upland inclusions are the primary landforms. Parent materials are medium textured tills, fine textured lacustrine deposits, coarse textured fluvial and eolian deposits, and organic deposits.

On upland areas, a mix of aspen-dominated deciduous stands, aspen–white spruce stands, and white spruce-dominated stands are typical of till and lacustrine areas, with jack pine forests on coarse materials. Wetlands are often extensive and are dominantly black spruce fens and bogs. Luvisolic soils are typical of uplands and Organic soils are dominant in wet, poorly drained areas.

Climate

The Central Mixedwood Natural Subregion spans nearly 8° of latitude, and several climatic trends are evident from the Alberta Climate Model analyses. Part 2 and Figures 2-1 through 2-4 provide a discussion and illustration of the trends presented below.

- Modeled growing degree-days are fairly constant across much of the Central Mixedwood Natural Subregion, but are higher along the Athabasca River north and south of Fort McMurray and adjacent to the Peace–Athabasca Delta Natural Subregion (Figure 2-3).
- Modeled mean annual temperatures become progressively cooler northward (Figure 2-1). The difference is most evident south and north of approximately 57°N latitude. It is paralleled by a northerly increase in the continentality index (the difference between the average summer maximum and winter minimum temperatures). The most evident change occurs at about the same latitude as mean annual temperature, and indicates lower average modeled winter temperatures.
- Modeled mean annual precipitation shows a similar decrease from south to north, again with the most evident change in a band about 200 km wide centered on the 57th parallel (Figure 2-2). The modeled summer moisture index statistic indicates a higher potential for moisture deficits in the far northeastern part of the Central Mixedwood Natural Subregion than elsewhere.

The decreases in mean annual temperature and precipitation in moving north are likely related to the increasingly strong influence of dry, cold continental polar and continental arctic weather systems, as discussed in Part 1.

The notably higher concentration of small lakes and the occurrence of more extensive wetlands south of the 57th parallel might be related in part to higher precipitation and lower potential moisture deficits in that area. The higher proportion of mixedwood and coniferous stands in the Central Mixedwood Natural Subregion compared to the Dry Mixedwood Natural Subregion might also be related to higher precipitation, which could reduce the size and intensity of lightning-caused fires.

Table 3-2 provides annual and seasonal climatic statistics, and Figure 4-5.1 gives monthly temperature and precipitation patterns.

Vegetation

The Central Mixedwood Natural Subregion is characterized by a mix of aspen-dominated deciduous stands, aspen-white spruce forests, white spruce and jack pine stands on upland terrain. Wet, poorly drained fens and bogs overlie almost half the area. Vegetation-environment relationships are similar to those of the Dry Mixedwood Natural Subregion, with the main differences being a greater conifer presence and a larger array of moist-to-wet communities in the Central Mixedwood.

The Central Mixedwood Natural Subregion is characterized by a mix of aspen-dominated stands, aspen–white spruce forests. (Photo: S. Myers)

Willoughby et al. (2004) have synthesized the work of Beckingham and Archibald (1996), Thompson and Hansen (2003), Brierley et al. (1985) and others. The following summary of native plant communities and the community diagram in Figure 4-5.3 were abstracted from Willoughby et al. (2004).

Grasslands are very rare in the Central Mixedwood Natural Subregion, occurring only as patches in jack pine or black spruce forests on dry, coarse, well drained soils. Species include northern rice grass, Rocky Mountain fescue, dryland sedges, and plains wormwood.

Jack pine stands with lichen and bearberry understories are associated with rapidly drained, coarse textured glaciofluvial or eolian deposits. On coarse textured deposits where the water supply is somewhat greater, jack pine, aspen and white spruce occur in pure or mixed stands; understories include bearberry, common blueberry, green alder, prickly rose, wild lily-of-the-valley and hairy wild rye. Soils are typically Brunisols or weakly developed Gray Luvisols. These stand types occur extensively in the eastern part of the Natural Subregion near the Alberta–Saskatchewan border.

Reference community types on sites of average moisture and nutrient status in the Central Mixedwood Natural Subregion are aspen and aspen–white spruce stands with understories of low bush cranberry, rose, green alder, Canada buffaloberry, hairy wild rye, bunchberry, wild sarsaparilla, and dewberry. Typical soils are moderately fine textured Gray Luvisols and gleyed subgroups. White spruce–balsam fir–feathermoss communities develop if stand-replacing fires do not occur for a sufficiently long period. Along the Lower Foothills–Central Mixedwood boundary and at higher elevations in northern hill systems, lodgepole pine–jack pine hybrids occur as pure stands or with aspen.

Jack pine and black spruce stands with understories of common Labrador tea, bog cranberry and feathermosses occur on nutrient-poor sites. On wetter sites, black spruce is typically the leading species, and white spruce may also occur with black spruce where nutrient supplies are somewhat better. Soils are moderately well to poorly drained, variable textured Luvisols and gleyed subgroups, Brunisols and Gleysols.

On moist, rich sites, balsam poplar, aspen and white spruce occur as pure or mixed stands with understories of red-osier dogwood, prickly rose, and a diverse array of herbaceous species in deciduous and mixedwood stands or a carpet of feathermosses and horsetails in coniferous stands. Soil textures are variable, and soils are predominantly gleyed Luvisols.

Feather mosses are typical in older stands. (Photo: L. Allen)

Species-poor black spruce fens with common Labrador tea, peat moss and feathermosses and willow–dwarf birch shrublands with sedges and bluejoint are the most common wetland types. Tamarack, golden moss, and rich-site forbs and sedges are associated with better nutrient supplies. Organic soils are dominant, but Gleysols also occur.

Geology and Geomorphology

The Central Mixedwood Natural Subregion is characterized by gently undulating plains with minor inclusion of hummocky uplands. It includes a large portion of the northern Alberta Plains with extensions into the Northern Plains, the Saskatchewan Plains, the northern part of the Eastern Alberta Plains and some lower-elevation portions of the Northern Alberta Uplands. The underlying bedrock is mainly composed of Cretaceous shales with some sandstones and siltstones in the south and Devonian limestones, shales and siltstones in the northeast.

Surficial materials are a mix of origins and textures. Well to imperfectly drained uplands occupy about 60 percent of the total area. Of this area, about one third is underlain by fine textured glaciolacustrine materials, one third by coarse glaciofluvial and eolian sands, and the remaining one third by coarse to fine textured till.

The other 40 percent of the Natural Subregion is blanketed by organic deposits but these are not evenly distributed. In flat lacustrine areas, up to 80 percent may be organic terrain but in hummocky areas, organic deposits might only occur over 20 percent of the area.

Appendix 4 summarizes the proportional occurrence of landscape elements and parent materials in the Central Mixedwood Natural Subregion.

Water and Wetlands

Many small lakes occur in the Central Mixedwood Natural Subregion and are concentrated mainly south of 57°N latitude. These lakes, together with Utikuma Lake and larger watercourses such as the Peace, Athabasca, Wabasca, and Hay Rivers, account for about 3 percent of the total area.

Wetlands are a dominant component of the Central Mixedwood Natural Subregion; about 40 percent are wooded with shrubby fens on organic deposits, and about 5 percent are fens and marshes on wet mineral soils. There are major patterned fen systems on the sands west of Lake Claire, and discontinuous permafrost occurs in association with bogs in the northern part of the Natural Subregion.

Soils

Mineral soils are predominantly Gray Luvisols, but Dystric and Eutric Brunisols are associated with coarse textured sands that occupy about 10 percent of the area. Many of the Luvisols on these low-relief landforms are imperfectly drained and gleyed, and Solonetzic intergrades are associated with some of the glaciolacustrine sediments.

Mesisols are the dominant Organic soils occurring under fens and bogs, with Terric subgroups commonly occurring. Fibric Mesisols, Fibrisols and sometimes Cryosols are associated with bogs. Orthic and Peaty Gleysols occur over about 5 percent of the area.

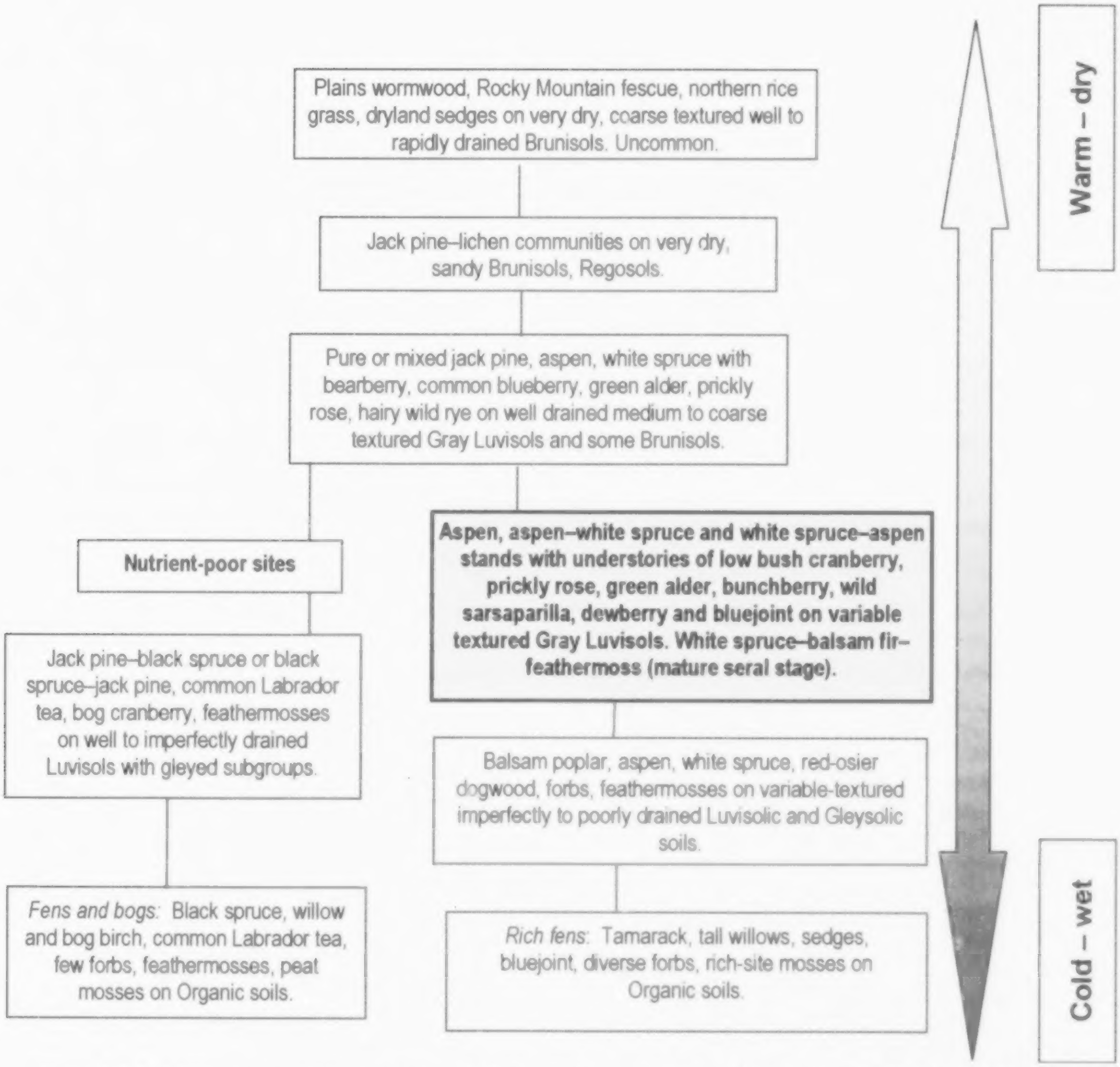
Appendix 7 summarizes the proportional occurrence of soil types in the Central Mixedwood Natural Subregion.

Land Uses

Significant aspen and conifer harvesting occurs throughout the Natural Subregion for pulp and softwood production. Intensive petroleum exploration and development occurs throughout the area, ranging from tar sands extraction in the northeast to conventional oil and gas production in the central and northwest portions. Agricultural uses are limited to hay crops and tame or native pasture domestic livestock grazing.

Hunting, fishing and trapping provide subsistence and income to some residents, and commercial hunting and fishing ventures operate throughout the Central Mixedwood Natural Subregion. Wood Buffalo National Park occupies a significant part of the northeast portion.

Aspen and balsam poplar with an understory of low bush cranberry and prickly rose. (Photo: L. Allen)



Plains wormwood, Rocky Mountain fescue, northern rice grass, dryland sedges on very dry, coarse textured well to rapidly drained Brunisols. Uncommon.

Jack pine–lichen communities on very dry, sandy Brunisols, Regosols.

Pure or mixed jack pine, aspen, white spruce with bearberry, common blueberry, green alder, prickly rose, hairy wild rye on well drained medium to coarse textured Gray Luvisols and some Brunisols.

Jack pine–black spruce or black spruce–jack pine, common Labrador tea, bog cranberry, feathermosses on well to imperfectly drained Luvisols with gleyed subgroups.

Fens and bogs: Black spruce, willow and bog birch, common Labrador tea, few forbs, feathermosses, peat mosses on Organic soils.

Aspen, aspen–white spruce and white spruce–aspen stands with understories of low bush cranberry, prickly rose, green alder, bunchberry, wild sarsaparilla, dewberry and bluejoint on variable textured Gray Luvisols. White spruce–balsam fir–feathermoss (mature seral stage).

Balsam poplar, aspen, white spruce, red-osier dogwood, forbs, feathermosses on variable-textured imperfectly to poorly drained Luvisolic and Gleysolic soils.

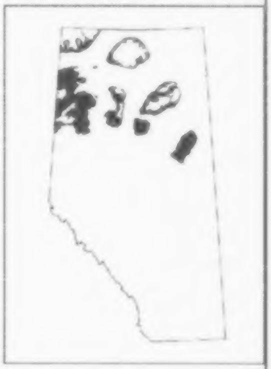
Rich fens: Tamarack, tall willows, sedges, bluejoint, diverse forbs, rich-site mosses on Organic soils.

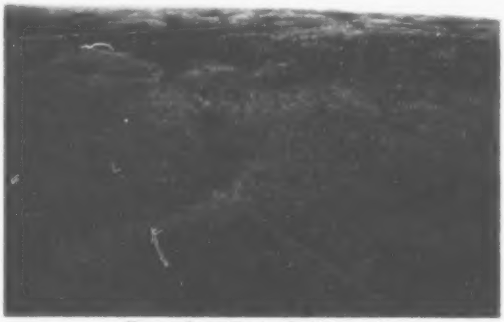
Figure 4-5.3. Common ecosystems arranged along environmental gradient, Central Mixedwood Natural Subregion. (*Reference site is in blue-shaded box in boldface type.*)

4.5.3 Lower Boreal Highlands Natural Subregion

Theme

Diverse mixedwood forests on moist lower slopes of northern hill systems and extensive wetlands at slope bases and on adjacent lowlands are typical of the Lower Boreal Highlands Natural Subregion.





Overview (Photo: D. Vujnovic)

Total area: 55,615 km² (15% of Boreal Forest Natural Region).

Average elevation: 700 m (range 400-1075 m).

Key Features

- Diverse young forests of aspen, balsam poplar, black and white spruce, white birch and lodgepole pine–jack pine hybrids on slopes with treed, shrubby or graminoid fens in depressions, seepage zones or level areas.
- Slightly colder winters and warmer summers than the higher-elevation Upper Boreal Highlands Natural Subregion. Moister and cooler than the adjacent Central Mixedwood and Dry Mixedwood Natural Subregions.
- Gray Luvisols (often gleyed); wetlands are Organic soils and Gleysols.

Bog cranberry is a common boreal species. (Photo: L. Allen)

General Description

The Lower Boreal Highlands Natural Subregion is the third largest Natural Subregion in Alberta and is the boreal analogue of the Lower Foothills Natural Subregion. It includes the lower slopes of the Cameron, Buffalo Head, Naylor and Clear Hills, Caribou and Birch Mountains, part of the Chinchaga Plain, and all the Stony Mountain and Peerless Uplands. It surrounds the higher elevation Upper Boreal Highlands and Boreal Subarctic Natural Subregions, and is bordered at lower elevations by the Central Mixedwood and Dry Mixedwood Natural Subregions. Elevations range between 400 m and 800 m in the Cameron Hills and Caribou Mountains, and between 700 m and 1000 m in the southern Clear Hills. This reflects a south-to-north decline of approximately 0.55 meters per kilometer for the upper boundary and a 0.82 m per kilometer decline for the lower boundary.

Medium textured glacial till deposits occur on gentle to strong lower slopes and hummocky to undulating uplands, with lacustrine and organic deposits in the lowlands. Forests are more diverse than those found in adjacent Natural Subregions. In addition to aspen and white spruce forests on uplands, balsam poplar and white birch forests often occur in seepage areas and lodgepole pine–jack pine hybrids are common in pure and mixed stands with black spruce and deciduous species. Luvisols and gleyed subgroups occur on well to imperfectly drained upland sites, Brunisols on coarse textured soils, and Organic soils and Gleysols on poorly drained areas.

Climate

The Lower Boreal Highlands Natural Subregion is cooler and somewhat moister than the neighboring Dry Mixedwood and Central Mixedwood Natural Subregions. It has slightly warmer summers but much colder winters than its southern analogue, the Lower Foothills Natural Subregion. Growing degree-days are markedly fewer in the Lower Boreal Highlands Natural Subregion than in lower elevation neighboring Natural Subregions. This is probably a reflection of the dual influence of higher elevations and more northerly latitudes. Peak precipitation occurs in July, and monthly precipitation patterns are very similar to those of adjacent Natural Subregions. Figure 4-5.1 provides a comparison of temperature and precipitation patterns between boreal Natural Subregions, and Table 3-2 gives annual and seasonal climate statistics.

Vegetation

Vegetation of the Lower Boreal Highlands Natural Subregion is not well documented. Beckingham and Archibald (1996), and Brierley et al. (1985) provide the most comprehensive community treatments, and Achuff (1994) provides some useful summary comments. Lee (1984) provides detailed information for the Clear Hills area. The following discussion and Figure 4-5.4 are a synthesis of these information sources, and many of the descriptions are very similar to those for the Central Mixedwood Natural Subregion. Brierley et al. (1985) report that lodgepole pine stands occur above about 600 m in the Clear and Naylor Hills; the trees are likely lodgepole pine–jack pine hybrids.

The Lower Boreal Highland Natural Subregion is the major zone of hybridization between lodgepole pine and jack pine. Stands may be dominated by pure lodgepole pine, pure jack pine and the full range of hybrids, with bearberry, lichen, common Labrador tea and common blueberry on the driest sites (generally coarse textured, rapidly drained glaciofluvial or eolian materials). Lodgepole pine–jack pine hybrids grow in pure or mixed stands with aspen and white birch, green alder, common Labrador tea, common blueberry and bog cranberry on well drained, coarse textured substrates. Brunisols are typically associated with these community types.

Reference community types on sites of average moisture and nutrient status in the Lower Boreal Highlands Natural Subregion are variable and may be pure or mixed stands of aspen, white spruce, white birch, hybrid pine and black spruce. White birch, balsam poplar, white spruce and hybrid pine tend to replace aspen as the dominant tree species in pure or mixed stands, at higher elevations and where seepage occurs. Pure white birch stands are a distinctive feature at upper elevations in the Lower Boreal Highlands. Understory species include rose, Canada buffaloberry, hairy wild rye, bluejoint, bunchberry, wild sarsaparilla, dewberry and feathermosses; species diversity likely decreases to the north.

Typical soils are moderately fine textured Gray Luvisols and gleyed subgroups. White spruce–feathermoss communities develop if stand-replacing fires do not occur for a sufficiently long period. These communities are relatively common in the Lower Boreal Highlands Natural Subregion; balsam fir is a common associate at higher elevations. On nutrient-poor sites, lodgepole pine–jack pine hybrids form stands with black spruce; understories include common Labrador tea, bog cranberry and feathermosses. On the wetter sites, black spruce is typically the leading species, and white spruce may also occur where nutrient conditions are somewhat better. Soils are moderately well to poorly drained, variable textured Luvisols and gleyed subgroups, Brunisols and Gleysols.

On moist, rich sites, balsam poplar, aspen and white spruce occur as pure or mixed stands with understories of red-osier dogwood, bracted honeysuckle, prickly rose, bluejoint and other herbs in deciduous and mixedwood stands, or a carpet of feathermosses and horsetails in coniferous stands. Tall willow communities with similar understories may also occur. These sites are typically found in association with seepage zones or along streams. Lee (1984) describes flat-leaved willow–Drummond's willow shrublands with bluejoint, sedges, dwarf raspberry and peat mosses. Bluejoint may establish tall monocultures if the overstory is removed by fire or harvest. Soil textures are variable, and soils are Luvisols or Gleysols.

Wetlands include nutrient-poor black spruce fens with common Labrador tea, peat mosses and feathermosses. Tamarack–black spruce stands or willow–dwarf birch shrublands with sedges, bluejoint, golden moss and other rich-site vascular and non-vascular associates occur in wetlands receiving nutrient-rich waters. Organic soils are dominant and Gleysols are common.

Geology and Geomorphology

The Lower Boreal Highlands Natural Subregion includes the gently to strongly sloping lower elevations of the Northern Alberta Uplands, and also includes some undulating and hummocky upland areas. The underlying bedrock is a mixture of Cretaceous marine shales and sandstones. Medium textured glacial till on slopes and upland positions covers over 50 percent of the Natural Subregion, and shallow glaciolacustrine deposits occupy about 5 percent in toe slope and adjacent plain positions. Organic deposits, mainly in the broad Chinchaga valley, blanket about 30 percent of the area. Colluvium and residual materials occur in places on the steeper slopes, and there are scattered glaciofluvial deposits. Appendix 4 summarizes the proportional occurrence of landscape elements and parent materials in the Lower Boreal Highlands Natural Subregion.

Water and Wetlands

There is little open water in the Lower Boreal Highlands Natural Subregion other than a few small lakes in the Buffalo Head Hills, Peerless Upland and Birch Mountains. The Chinchaga and Birch Rivers are the largest watercourses. The total area covered by water is about 1 percent of the total land area in this Natural Subregion. Wetlands occur across about 35 percent of the area on average, but local percentages range from 20 to 60 percent. Wetlands are mainly treed and shrubby fens, except on the Chinchaga Plain to the north of the Clear Hills where bogs make up about 50 percent of the wetland area. Wet mineral soils occupy about 5 to 10 percent of the total area.

Soils

Orthic Gray Luvisols are the dominant upland soils; gleyed subgroups are common. There is some seepage on lower slopes. Regosols occur on steep erosional slopes. Typic and Terric Mesisols are the dominant organic soils in poor-to-rich fens. Fibric Mesisols and occasional Organic Cryosols are typical of bogs. Peaty Gleysols are common throughout the Natural Subregion. Appendix 7 summarizes the proportional occurrence of soil types in the Lower Boreal Highlands Natural Subregion.

Land Uses

Significant aspen and conifer harvesting occurs throughout the Natural Subregion for pulp and softwood production. Intensive petroleum exploration and development has occurred in the Cameron Hills area. In addition, there is oilsands potential in northeastern Alberta. Hunting, fishing and trapping provide subsistence and income to some residents. Agricultural potential is severely limited by the short growing season.

White birch stands are a distinctive feature at upper elevations in the Lower Boreal Highlands.
(Photo: L. Allen)

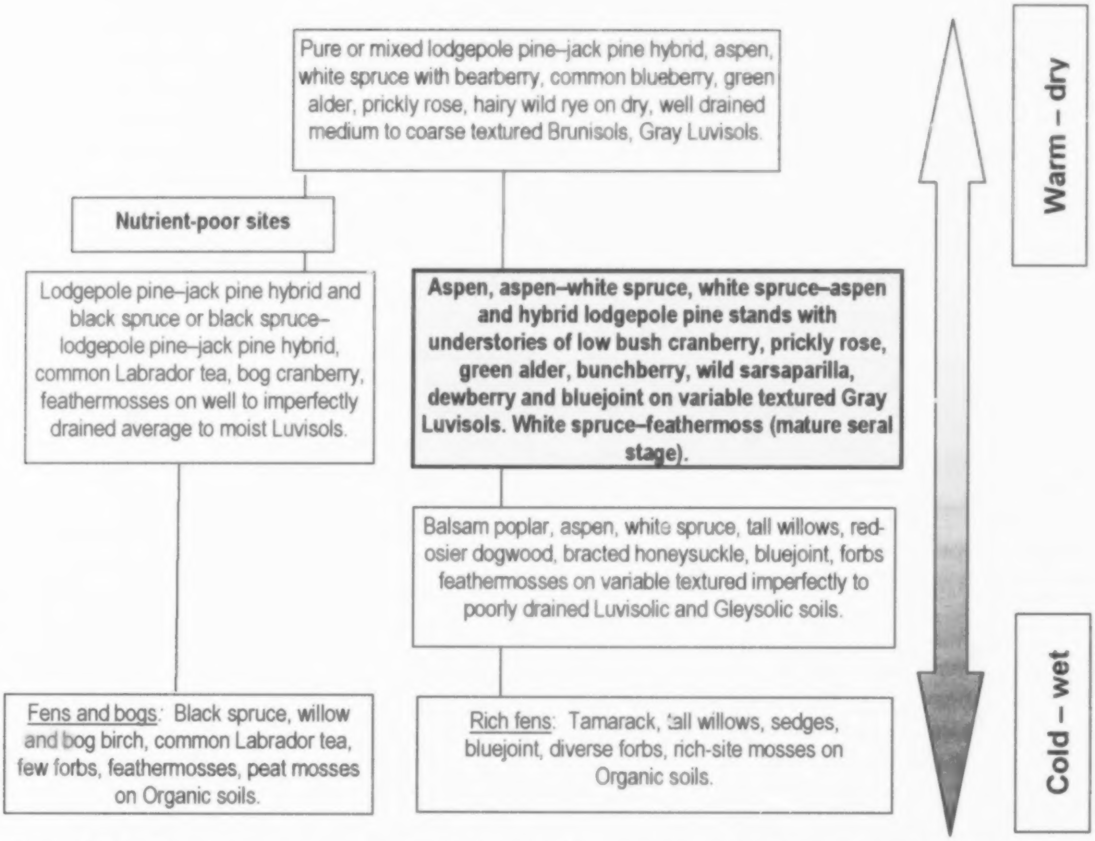
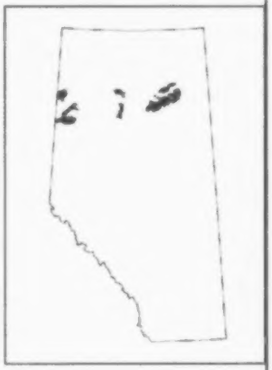

Pure or mixed lodgepole pine–jack pine hybrid, aspen, white spruce with bearberry, common blueberry, green alder, prickly rose, hairy wild rye on dry, well drained medium to coarse textured Brunisols, Gray Luvisols.
Nutrient-poor sites
Lodgepole pine–jack pine hybrid and black spruce or black spruce–lodgepole pine–jack pine hybrid, common Labrador tea, bog cranberry, feathermosses on well to imperfectly drained average to moist Luvisols.
Aspen, aspen–white spruce, white spruce–aspen and hybrid lodgepole pine stands with understories of low bush cranberry, prickly rose, green alder, bunchberry, wild sarsaparilla, dewberry and bluejoint on variable textured Gray Luvisols. White spruce–feathermoss (mature seral stage).
Balsam poplar, aspen, white spruce, tall willows, red-osier dogwood, bracted honeysuckle, bluejoint, forbs feathermosses on variable textured imperfectly to poorly drained Luvisolic and Gleysolic soils.
Fens and bogs: Black spruce, willow and bog birch, common Labrador tea, few forbs, feathermosses, peat mosses on Organic soils.
Rich fens: Tamarack, tall willows, sedges, bluejoint, diverse forbs, rich-site mosses on Organic soils.
Warm – dry
Cold – wet

Figure 4-5.4. Common ecosystems arranged along environmental gradient, Lower Boreal Highlands Natural Subregion. (*Reference site is in blue-shaded box in boldface type.*)

4.5.4 Upper Boreal Highlands Natural Subregion

Theme

Coniferous forests on the upper slopes and undulating plateaus of northern hill systems, short, cool and showery summers and cold winters together define the Upper Boreal Highlands Natural Subregion.



Key Features

- Predominantly coniferous forests (lodgepole pine–jack pine hybrids, white and black spruce) with locally extensive wetlands in low-lying portions of the plateaus.
- Moister with cooler summers than the adjacent Lower Boreal Highlands Natural Subregion.
- Orthic and Brunisolic Gray Luvisols (often gleyed); wetlands are Organic soils and Gleysols.

Overview (Photo: D. Vujnovic)

Total area: 11,858 km² (3% of Boreal Forest Natural Region).

Average elevation: 825 m (range 650-1150 m).

Bunchberry is a common species in the understory of these species-poor forests. (Photo: L. Allen)

General Description

The Upper Boreal Highlands Natural Subregion includes the upper slopes and plateaus of the Buffalo Head, Naylor and Clear Hills, and the Birch Mountains. It is entirely surrounded by the Lower Boreal Highlands Natural Subregion. Elevations range from 825 m in the eastern Birch Mountains to 1100 m in the western Clear Hills. Medium textured glacial till deposits occur on slopes, with colluvial and residual materials on steep slopes and organic deposits in depressions on the plateaus. Forests are mainly coniferous, and both lodgepole pine and lodgepole pine–jack pine hybrids occur together with black spruce. Luvisols and gleyed subgroups occur on well to imperfectly drained upland sites, and Organic soils, Cryosols and Gleysols occur on poorly drained areas.

Climate

The Upper Boreal Highlands Natural Subregion has shorter, cooler summers and lower growing degree-day accumulations than the surrounding Lower Boreal Highlands Natural Subregion. It has slightly warmer summers and similar growing degree-day accumulations, but much colder winters and lower precipitation than its southern analogue, the Upper Foothills Natural Subregion. This is probably a reflection of the increased influence of continental polar weather systems and the much reduced influence of westerly winter Chinook-like winds at northerly latitudes.

Peak precipitation occurs in July, and monthly precipitation patterns are very similar to those of the Lower Boreal Highlands Natural Subregion, with slightly higher winter precipitation. Figure 4-5.1 provides a comparison of temperature and precipitation patterns between boreal Natural Subregions, and Table 3-2 gives annual and seasonal climate statistics.

Vegetation

Vegetation characteristics of the Upper Boreal Highlands Natural Subregion are poorly documented. Beckingham and Archibald (1996) provide general community information for both the Lower and Upper Boreal Highlands Natural Subregions based on a small sample. Lee (1984) provides detailed descriptions for the major community types in this Natural Subregion in the Clear Hills.

It is probable the general vegetation-environment relationships presented for the Lower Boreal Highlands are applicable to the Upper Boreal Highlands, but species composition changes with elevation. As well, early successional stands in the Upper Boreal Highlands are more likely to be dominated by lodgepole pine stands in the Upper Boreal Foothills. Where lodgepole pine–jack pine hybrids occur, lodgepole pine characters are clearly dominant.

At higher elevations, lodgepole pine or lodgepole pine x jack pine hybrid communities with low species diversity replace more diverse mixedwood stands, a trend similar to that noted for the Lower and Upper Foothills Natural Subregions in Part 4.2. At the highest elevations in the Clear Hills, pure lodgepole pine stands with species-poor understories are common, and there are no aspen-leading mixedwood or pure aspen forests. Nutrient and moisture inputs from seepage are less influential in the Upper Boreal Highlands than in the Lower Boreal Highlands, but seepage is locally important. The following discussion and Figure 4-5.5 present a tentative vegetation-environment sequence for the Upper Boreal Highlands Natural Subregion.

Lodgepole pine or lodgepole pine x jack pine hybrid stands with bearberry, lichen, common Labrador tea and common blueberry occupy the driest sites, generally coarse textured rapidly drained glaciofluvial or eolian materials. Lodgepole pine grows in pure or mixed stands with aspen and white birch, green alder, beaked willow, Scouler's willow, common Labrador tea, common blueberry, and bog cranberry on well drained coarse textured substrates. Brunisols are typically associated with these community types. Reference community types on sites of average moisture and low-to-average nutrient status in the Upper Boreal Highlands Natural Subregion are predominantly young to mid-successional lodgepole pine–jack pine hybrids or pure lodgepole pine at the highest elevations. Black spruce often establishes at the same time as pine, but forms a secondary canopy below the main canopy owing to slower growth.

Forest understories are typically species-poor, and include common Labrador tea, bog cranberry, bunchberry, dewberry, twinflower and feathermosses. Species indicative of higher elevations in the Foothills Natural Region, such as tall bilberry and dwarf bramble, have not been reported from the Upper Boreal Highlands Natural Subregion. Aspen and balsam poplar-dominated stands are uncommon on reference sites and stand growth is usually poor. Aspen tends to be replaced by white birch in deciduous and mixedwood stands of this Natural Subregion.

Typical soils are medium textured Gray Luvisols, with Brunisolic Gray Luvisols and Brunisols occurring more commonly at the highest elevations. White spruce or white spruce–balsam fir stands with feathermoss understories are limited in extent, probably because of frequent stand-replacing fires.

Moist, rich sites are uncommon; pure or mixed stands including aspen and balsam poplar along with white and black spruce and pine hybrids occur. Typical understories include prickly rose, bracted honeysuckle, bluejoint and other herbs in deciduous and mixedwood stands or feathermosses and horsetails in coniferous stands. These sites are often found in seepage areas or along streams. Soil textures are variable, and soils are Luvisols or Gleysols. Wetlands include nutrient-poor black spruce fens and bogs with common Labrador tea, peat mosses, cloudberry and feathermosses. Permafrost occurs under some stands. Open tamarack–black spruce fens or willow–dwarf birch fens with sedges, bluejoint, golden moss and other rich-site vascular and non-vascular associates occur in wetlands receiving nutrient-rich waters. Organic soils are dominant and Gleysols are common, with Organic Cryosols occurring on permafrost.

Geology and Geomorphology

Steeply sloping dissected plateaus and undulating and hummocky upper plateau surfaces define the Upper Boreal Highlands Natural Subregion. Cretaceous marine shales underlie the hill systems; sandstones occur in the Clear Hills. Medium textured glacial tills are the dominant surficial materials, with about 30 percent organic deposits on the plateau surfaces. Colluvium and residual materials occur in places on steeper slopes, and scattered glaciofluvial deposits also occur. Appendix 4 summarizes the proportional occurrence of landscape elements and parent materials in the Upper Boreal Highlands Natural Subregion.

Water and Wetlands

Small lakes occur atop the Buffalo Head Hills and Birch Mountains on undulating portions of the plateaus, and occupy 1 to 2 percent of the Upper Boreal Highlands Natural Subregion. Wetlands are similarly associated with depressions within the plateau. They average 30 percent cover across the Natural Subregion, but may occur over up to 50 percent of the landscape in some areas. Treed and shrubby bogs and fens are the dominant wetland types and the underlying organic deposits are often permanently frozen. Seepage zones along the slopes are associated with wet mineral soils or thin organic accumulations.

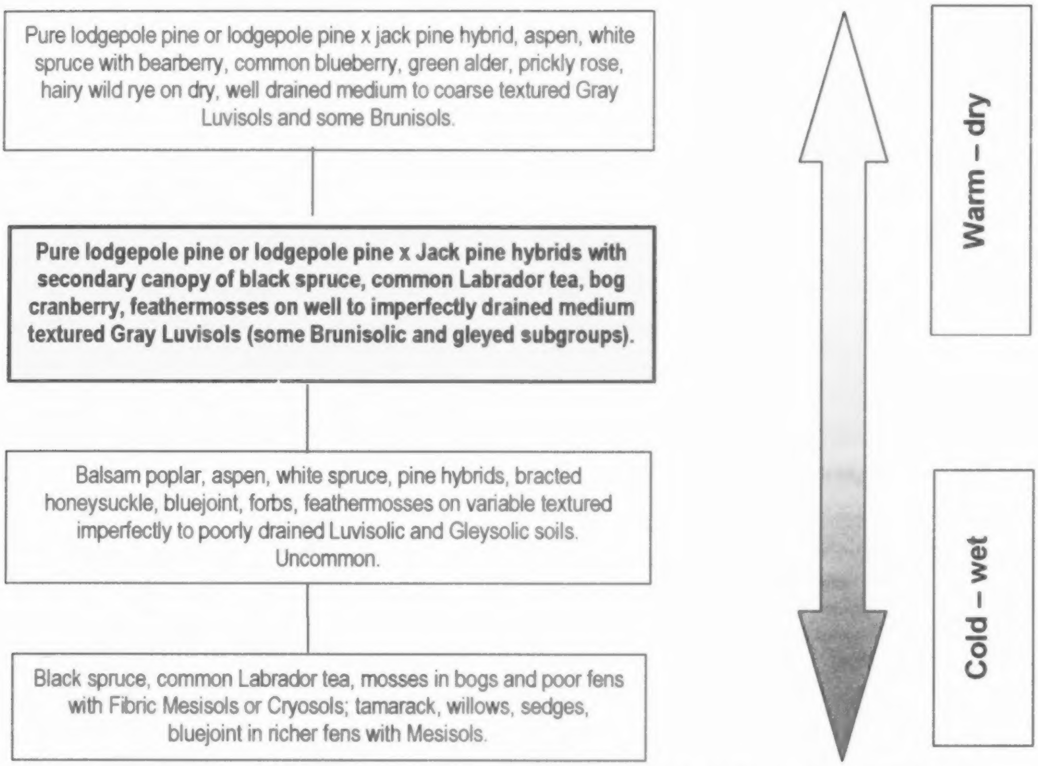
Soils

The cold, moist environment of the Upper Boreal Highlands Natural Subregion results in weakly developed soils. Upland soils occupy about 65 percent of the Natural Subregion. Orthic Gray Luvisols are dominant, with significant occurrences of Gleyed Gray Luvisols, Eluviated and Gleyed Eutric Brunisols, and Brunisolic Gray Luvisols. Mesisols are associated with fens and occupy about 15 percent of the Natural Subregion. Fibric Mesisols and Organic Cryosols are associated with bogs and also occupy about 15 percent of the area. Rego and Peaty Gleysols occur on wet seepage sites across the remaining 5 percent of the Natural Subregion. Appendix 7 summarizes the proportional occurrence of soil types in the Upper Boreal Highlands Natural Subregion.

Land Uses

Limited softwood harvesting occurs in this Natural Subregion because of poor access and relatively low volumes. Conventional oil and gas production is a minor activity, but oilsands potential exists in the Birch Mountains northwest of Fort McMurray. Hunting, fishing and trapping provide subsistence and income to some residents. The area has no agricultural potential.

Black spruce/feathermoss stands are found occasionally on imperfectly drained sites. (Photo: L. Allen)



Pure lodgepole pine or lodgepole pine x jack pine hybrid, aspen, white spruce with bearberry, common blueberry, green alder, prickly rose, hairy wild rye on dry, well drained medium to coarse textured Gray Luvisols and some Brunisols.

Pure lodgepole pine or lodgepole pine x Jack pine hybrids with secondary canopy of black spruce, common Labrador tea, bog cranberry, feathermosses on well to imperfectly drained medium textured Gray Luvisols (some Brunisolic and gleyed subgroups).

Balsam poplar, aspen, white spruce, pine hybrids, bracted honeysuckle, bluejoint, forbs, feathermosses on variable textured imperfectly to poorly drained Luvisolic and Gleysolic soils. Uncommon.

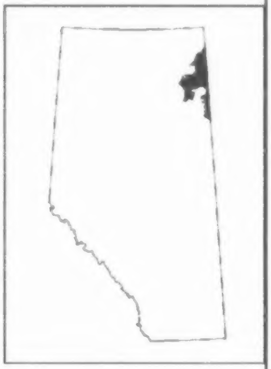
Black spruce, common Labrador tea, mosses in bogs and poor fens with Fibric Mesisols or Cryosols; tamarack, willows, sedges, bluejoint in richer fens with Mesisols.

Figure 4-5.5. Common ecosystems arranged along environmental gradient, Upper Boreal Highlands Natural Subregion. (*Reference site is in blue-shaded box in boldface type.*)

4.5.5 Athabasca Plain Natural Subregion

Theme

Dry, sandy plains, dune fields and gravel-cored hill systems, open shrub or jack pine communities, warm summers and long, very cold winters together define the Athabasca Plain Natural Subregion.



Key Features

- Coarse textured gravels and sands throughout the entire area.
- Relatively warm summers and long growing seasons compared to other boreal Natural Subregions.
- Jack pine forests and low shrublands with sedge fens in low areas and some unvegetated areas (active dunes). Soils are Brunisols, Regosols or Mesisols.

Overview (Photo: A. Landals)

Total area: 13,525 km^2 (4% of Boreal Forest Natural Region).

Average elevation: 300 m (range 200-650 m).

Lichens often dominate the understory of dry jack pine stands. (Photo: L. Allen)

General Description

The Athabasca Plain Natural Subregion occurs south of Lake Athabasca along the Alberta–Saskatchewan border. Adjacent Natural Subregions are the Kazan Upland and Peace–Athabasca Delta to the north and northwest, and the Central Mixedwood to the east. Elevations range from 200 m near Lake Athabasca to about 650 m in the southeastern Firebag Hills.

Strongly hummocky and rolling sandy and gravelly uplands occur in the eastern and southern portions. Level to undulating sandy fluvial and eolian plains with some prominent dune fields occur to the east and north. Dune areas have unique communities that stabilize the dune surfaces, but areas of bare sand do exist. Elsewhere, dry jack pine stands with sparse understories are the dominant upland vegetation, with sedge meadows in low-lying terrain. Soils are Brunisols on the uplands, Regosols on the active dunes, and Mesisols in wetlands. The Athabasca Plain Subregion has a number of significant invertebrate species that are out of range, rare, or are the first records for this part of Alberta.

Climate

The Athabasca Plain Natural Subregion and its northern neighbour, the Peace–Athabasca Delta Natural Subregion, have the warmest summers of any boreal Natural Subregion. Winters are very cold, reflecting the influence of continental polar and continental arctic weather systems. The Alberta Climate Model (see Part 2 of this document) shows an increase in mean annual precipitation and a corresponding decrease in potential moisture deficits (summer moisture index) to the south in hill systems along the Alberta–Saskatchewan border. The month of maximum precipitation is July. Figure 4-5.1 provides a comparison of temperature and precipitation patterns between boreal Natural Subregions, and Table 3-2 shows annual and seasonal climate statistics.

Vegetation

Vegetation characteristics of the Athabasca Plain Natural Subregion are poorly documented. Beckingham and Archibald (1996) provide general community information for the Kazan Upland and Athabasca Plain Natural Subregions based on a small sample. Allen et al. (2003) and Wallis and Wershler (1984) provide additional useful information. The following discussion and Figure 4-5.6 present a tentative vegetation–environment sequence for the Athabasca Plain Natural Subregion. Very dry, gravelly plains and sand dunes are largely unvegetated. In places, unique communities that contain species such as sand heather, June grass, hay sedge and western wheat grass help stabilize the dunes. Soils are rapidly drained Regosols.

Sand heather is an early stabilizer at the edges of the dune fields. (Photo: D. Vujnovic)

Reference sites in the Athabasca Plain Natural Subregion with deep, well to moderately well drained medium textured soils, are very uncommon. The most common and characteristic vegetation types are dry jack pine stands with understories of lichen, bearberry, common blueberry, bog cranberry and Canada buffaloberry. White spruce may be co-dominant on some sites, but pure mature white spruce stands are uncommon because of frequent fire return intervals. Soils are dry, rapidly drained, coarse textured Brunisols.

Moister locales (for example, northerly slopes or lower slope positions) allow the growth of understory species such as green alder, rose, low bush cranberry and feathermosses. Overstories of aspen, white birch, Alaska birch and jack pine occur as pure stands or in mixtures. On nutrient-poor sites, jack pine and black spruce form the overstory, with bog cranberry, common Labrador tea and feathermosses in the understory. Well drained, moderately moist Brunisols and Luvisols are typically associated with these sites.

Moist, rich sites are relatively uncommon, occurring mainly along rivers and in narrow zones around small lakes. Here, pure or mixed stands of aspen, balsam poplar and white birch occur, along with white and black spruce. Willows, river alder, low bush cranberry and horsetails are common. Species diversity appears to be less than that on similar sites in the adjacent Central Mixedwood Natural Subregion. Soil textures are variable but are predominantly sandy; soil types range from Gleyed Brunisols and Luvisols to Gleysols.

Wetlands are a complex of treed, shrubby and graminoid fens. Treed fens include black spruce, common Labrador tea, leatherleaf, and peat mosses or feathermosses. Tamarack occurs with golden mosses and sedge where nutrient supplies are better. Willow, leatherleaf, dwarf birch and sedges are common components of shrubby fens. Water sedge, bluejoint and other graminoid species are typical species of sedge fens. Soils are poorly drained Mesisols with significant occurrences of Gleysols.

Geology and Geomorphology

Landforms in the Athabasca Plain Natural Subregion include the gently undulating and duned Embarrass Plain, the hummocky Richardson Hills, and the strongly rolling and hummocky Firebag Hills. The underlying bedrock ranges from Helikian sandstone in the north and east to Devonian sandstone, siltstone and dolomite in the southwest, to Cretaceous nonmarine sandstone, siltstone and shale formations in the southeast.

Surficial deposits are all deep, extremely coarse textured sediments. Glaciofluvial, deltaic and eolian sands occur on the plains, and sandy and gravelly ice-contact materials are associated with hummocky terrain. Some dunes are active while others are stabilized; dune forms include longitudinal and U-shaped dunes. Appendix 4 summarizes the proportional occurrence of landscape elements and parent materials in the Athabasca Plain Natural Subregion.

Extensive sand dunes are a common feature.
(Photo: D. Vujnovic)

Water and Wetlands

Three percent of the Athabasca Plain Natural Subregion is covered with water. There are almost no open water bodies on the plains, but there may be over 5 percent water in hummocky terrain, occurring mainly as small pothole lakes. The Athabasca River runs through the western part of the area. Several smaller rivers (Richardson, Old Fort, Harrison, Marguerite and Firebag) also drain the area.

Wetlands cover about 25 percent of the Athabasca Plain Natural Subregion, but their distribution ranges from about 10 percent in the western plains to over 50 percent in the eastern portions. Wetlands are mainly treed and graminoid fens, but nutrient-poor treed bogs also occur.

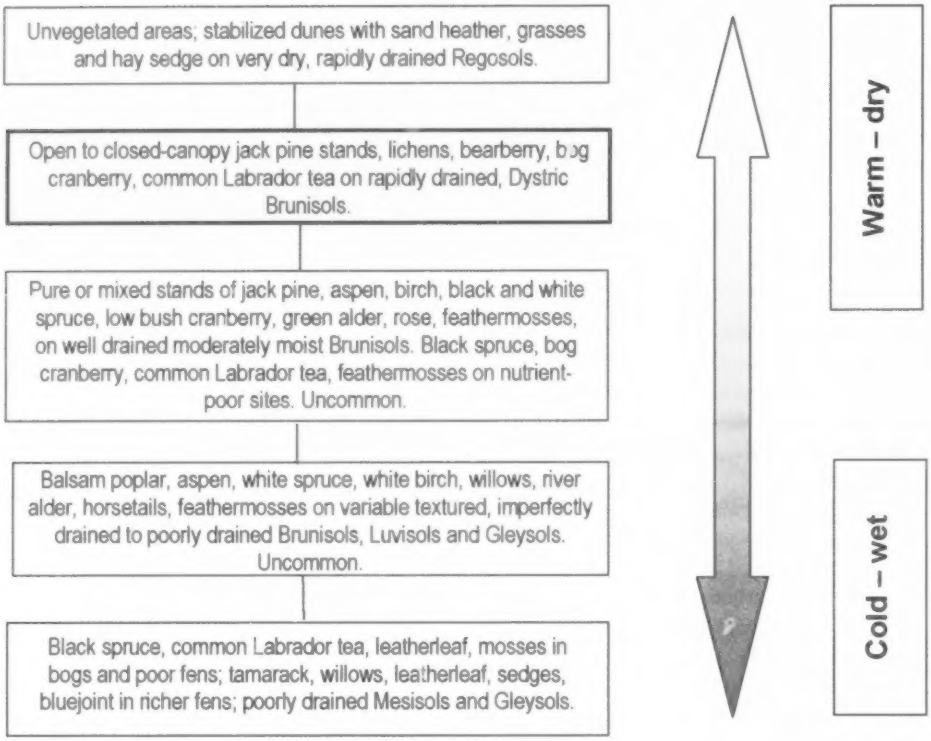
Soils

Acidic Dystric Brunisols are the dominant soils on rapidly drained sands. Gleyed soils and Gleysols are also common in depressions. There, Brunisolic Gray Luvisols occur in association with ice-contact materials. Wetlands are mainly Terric and Typic Mesisols with significant occurrences of both peaty and non-peaty Orthic Gleysols. Appendix 7 summarizes the proportional occurrence of soil types in the Athabasca Plain Natural Subregion.

Land Uses

Limited softwood harvesting occurs in the Athabasca Plain Natural Subregion because of poor access and relatively low volumes. Conventional oil and gas production is limited, but there is oilsands potential in the southern part of the area. Hunting, fishing and trapping provide income and subsistence to some residents. Despite a relatively long summer growing season, the area has no agricultural potential because of unfavourable soil conditions.

Jack pine–lichen communities are extensive on very dry sites.


Unvegetated areas; stabilized dunes with sand heather, grasses and hay sedge on very dry, rapidly drained Regosols.

Open to closed-canopy jack pine stands, lichens, bearberry, bog cranberry, common Labrador tea on rapidly drained, Dystric Brunisols.

Pure or mixed stands of jack pine, aspen, birch, black and white spruce, low bush cranberry, green alder, rose, feathermosses, on well drained moderately moist Brunisols. Black spruce, bog cranberry, common Labrador tea, feathermosses on nutrient-poor sites. Uncommon.

Balsam poplar, aspen, white spruce, white birch, willows, river alder, horsetails, feathermosses on variable textured, imperfectly drained to poorly drained Brunisols, Luvisols and Gleysols. Uncommon.

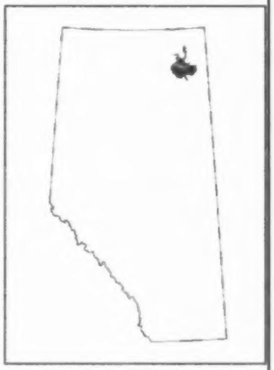
Black spruce, common Labrador tea, leatherleaf, mosses in bogs and poor fens; tamarack, willows, leatherleaf, sedges, bluejoint in richer fens; poorly drained Mesisols and Gleysols.

Figure 4-5.6. Common ecosystems arranged along environmental gradient, Athabasca Plain Natural Subregion. (*Characteristic site is in yellow-shaded box.*)

4.5.6 Peace–Athabasca Delta Natural Subregion

Theme

The Peace–Athabasca Delta Natural Subregion is a wet expanse of lakes, rivers, creeks, marshes, sedge meadows, shrublands and riverine forests; summers are warm and winters are long and very cold.



Overview (Photo: C. Wallis)

Total area: 5535 km² (1% of Boreal Forest Natural Region).
Average elevation: 225 m (range 200-250 m)

Key Features

- One of the world's largest freshwater deltas.
- Warm summers and long growing seasons, very cold winters.
- Many large and small lakes, extensive sedge meadows and willow-dominated shrublands underlain by wet mineral soils; Organic soils are uncommon.

Extensive meadows of awned sedge are found throughout the delta. (Photo: L. Allen)

General Description

The Peace–Athabasca Delta Natural Subregion lies south and west of Lake Athabasca. It is bordered on the west by the Central Mixedwood Natural Subregion, on the north by the Kazan Uplands Natural Subregion, and on the east and south by the Athabasca Plain Natural Subregion. It is the lowest elevation Natural Subregion in the province and is nearly flat. Elevations range from 200 m along the Slave River to about 250 m in small elevated granite exposures within the Delta. Water is the dominant feature. Most of the vegetation throughout the Natural Subregion is a mixture of submerged and emergent aquatic communities, sedge fens and willow shrublands. Deciduous and coniferous forests occur on fluvial terraces or levees along streams and rivers, and dry jack pine forests and lichen communities occur on granite exposure. Soils are Regosols and Gleysols. Only very minor parts of the area in the Peace–Athabasca Delta Natural Subregion are occupied by deep, medium textured, well drained soils and their associated vegetation. The site characteristic of most of the area in this Natural Subregion is wet, nutrient rich, and vegetated by sedges, other grass-like plants, herbs and shrubs.

Climate

The Peace–Athabasca Delta Natural Subregion has the warmest summers and highest growing season degree-day accumulations of any boreal Natural Subregion. Winters are very cold, reflecting the influence of continental polar and continental arctic weather systems. The month of maximum precipitation is July, and winter snowfalls are low.

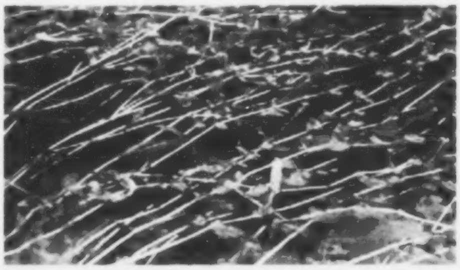
This Natural Subregion is a wet landscape. The Alberta Climate Model (see Part 2 of this document) shows the Peace–Athabasca Delta to be climatically one of the driest Natural Subregions in the province, with mean annual precipitation approximately equal to the Mixedgrass Natural Subregion. However, this apparent climatic similarity is not reflected in the subregional vegetation patterns. Grassland and Peace–Athabasca Delta vegetation communities are completely different. High-water tables in the Peace–Athabasca Delta area and relatively low solar inputs at higher latitudes override climatic moisture deficits to produce extensive areas of wetland vegetation.

Figure 4-5.1 provides a comparison of temperature and precipitation patterns between boreal Natural Subregions, and Table 3-2 gives annual and seasonal climate statistics.

Vegetation

Water is the main factor determining the type and distribution of vegetation communities in the Peace–Athabasca Delta Natural Subregion. Periodic flooding and sedimentation caused by ice jams and seasonal increases in river flows can cause significant changes over time in some areas. Differences of less than 1 m in local topography produce diverse and complex community structures. The following discussion and Figure 4-5.7 present a tentative vegetation-environment sequence for the Peace–Athabasca Delta Natural Subregion, based on three sources (Achuff 1994; Anon. [n.d.]; and notes of the Natural Regions and Subregions review committee).

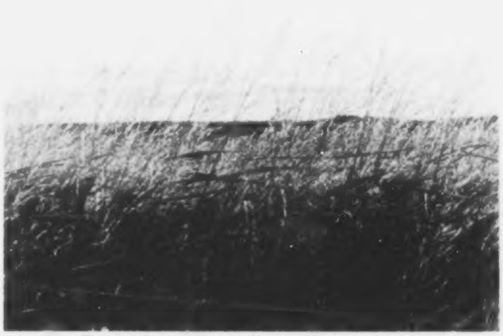
In shallow, open water areas, submerged and floating pondweeds form communities. Along shorelines, bands of emergent vegetation develop. Species include bulrushes, cattail, bluejoint, small bottle sedge and swamp horsetail. As water levels drop throughout the growing season, extensive and largely unvegetated mudflats may be exposed. Annual species such as samphire provide patchy vegetation cover on mudflats.



Richardson's pondweed commonly dominates some of the aquatic communities. (Photo: L. Allen)

There are no community type–soil combinations within this Natural Subregion that match the definition of reference sites (medium textured, well to moderately well drained soils). Characteristic sites for terrestrial portions of the Peace–Athabasca Delta Natural Subregion include sedge meadows and shrublands.

Extensive sedge meadows occur where the water table is near or at the surface, and are composed of awned, small bottle and water sedge, spangletop, swamp horsetail, common tall manna grass and bluejoint.



Spangletop meadow. (Photo: L. Allen)

Shrub communities composed of various willow species, green alder, river alder, and red-osier dogwood develop on slightly elevated sites adjacent to streams and ponds where the water table is below the surface. Soils are Regosols, gleyed Regosols and Gleysols.

On slightly elevated and drier stream terraces and levees, recently disturbed areas are often densely vegetated by sandbar willow. Less recently disturbed sites support pure or mixed stands of balsam poplar, white birch and white spruce, with understories of river alder, red-osier dogwood and meadow horsetail. Scattered mature stands of white spruce with understories of balsam fir and feathermosses also occur. Soils are Regosols and Brunisols.

A few granite outliers of the Canadian Shield occur within the northeast portion of the Peace–Athabasca Delta Natural Subregion. They include rock barrens and dry, open jack pine communities with variable understories.

Geology and Geomorphology

Recent alluvial deposits of the Peace–Athabasca Delta and large open water areas characterize this Natural Subregion. Alluvial features include ponds, active rivers, levees, point bars, abandoned channels, oxbows, mud flats, floodplains, shorelines and terraces. The underlying bedrock is mainly Devonian limestones and shales with Helikian non-marine sandstones on the east side and Aphebian granitoids of the Canadian Shield on the northeast. Alluvial materials are usually silty or sandy textured.

Appendix 4 summarizes the proportional occurrence of landscape elements and parent materials in the Peace–Athabasca Delta Natural Subregion.

Water and Wetlands

The Peace–Athabasca Natural Subregion has the highest proportion of water to land of any Natural Subregion in Alberta. The Claire, Mamawi, Baril and Richardson Lakes and channels of the Athabasca and Peace Rivers cover about 40 percent of the total area. Wetlands are composed of emergent, graminoid or shrubby vegetation, occurring mainly on wet mineral soils and account for a further 20 percent of the total area. Organic deposits have developed in places such as higher terraces where flooding and disturbance are infrequent.

Soils

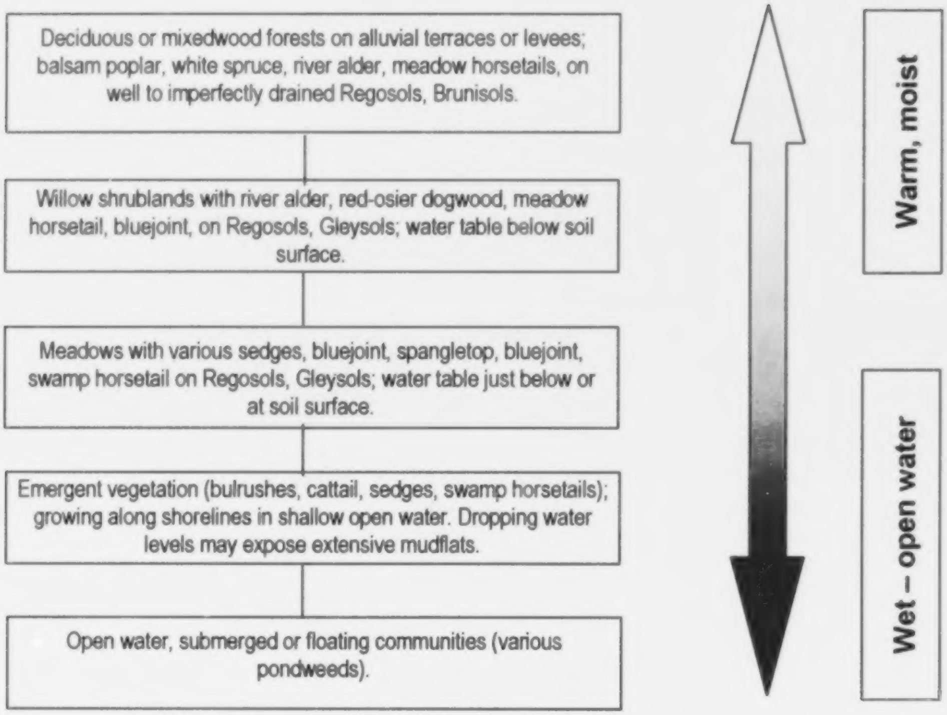
Because of frequent flooding, siltation and high water tables, soils on elevated terrain are mainly Orthic and Gleyed Cumulic Regosols. Brunisols may be found on higher terraces where flooding is more infrequent and soil profiles have had time to develop. Wetlands are mainly Rego Gleysols with some peaty Gleysols and Mesisols in more stable sites.

Appendix 7 summarizes the proportional occurrence of soil types in the Peace–Athabasca Delta Natural Subregion.

Land Uses

Much of the area lies within Wood Buffalo National Park. There is no forestry or oil and gas activity. Hunting, fishing and trapping provide income and subsistence to some residents.

A common pattern of vegetation in the Peace–Athabasca Delta is extensive sedge meadows bordered by willow shrublands with balsam poplar stands on elevated levees. (Photo: D. Vujnovic)



Deciduous or mixedwood forests on alluvial terraces or levees; balsam poplar, white spruce, river alder, meadow horsetails, on well to imperfectly drained Regosols, Brunisols.

Willow shrublands with river alder, red-osier dogwood, meadow horsetail, bluejoint, on Regosols, Gleysols; water table below soil surface.

Meadows with various sedges, bluejoint, spangletop, bluejoint, swamp horsetail on Regosols, Gleysols; water table just below or at soil surface.

Emergent vegetation (bulrushes, cattail, sedges, swamp horsetails); growing along shorelines in shallow open water. Dropping water levels may expose extensive mudflats.

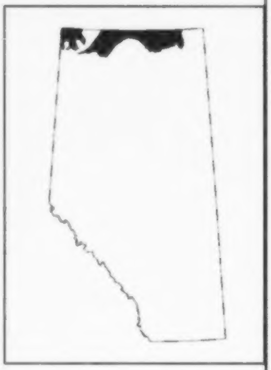
Open water, submerged or floating communities (various pondweeds).

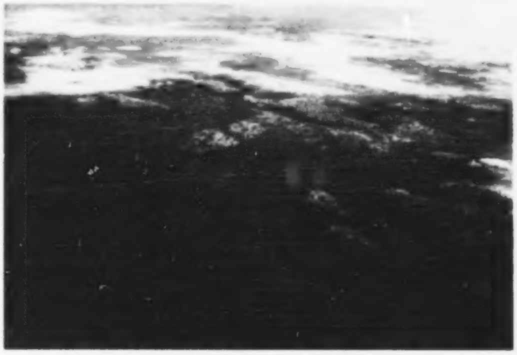
Figure 4-5.7. Common ecosystems arranged along environmental gradient, Peace–Athabasca Delta Natural Subregion. (*Characteristic sites are in yellow-shaded boxes.*)

4.5.7 Northern Mixedwood Natural Subregion

Theme

Far northern low-elevation black spruce bogs and fens, frozen Organic soils, short, warm and dry summers and long, very cold winters define the Northern Mixedwood Natural Subregion.

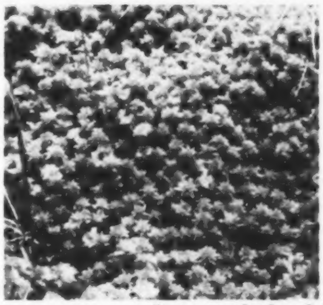




Overview (Photo: D. Vujnovic)

Total area: 29,513 km² (8% of Boreal Forest Natural Region).

Average elevation: 350 m (range 150-650 m.



Sphagnum mosses are characterixtic of the many bogs in the subregion. (Photo: L. Allen)

Key Features

- Wetlands with Organic soils are the dominant landscape feature, and permafrost occurs over significant areas.
- Black spruce is common both on uplands and in wetlands; deciduous and mixedwood stands are uncommon, restricted to river terraces, valleys, and elevated well drained areas.

General Description

The Northern Mixedwood Natural Subregion occurs in the far north, occupying the lowlands adjacent to the Alberta–Northwest Territories border and a smaller, higher elevation area in the northwestern Cameron Hills. Its main border is with the Central Mixedwood Natural Subregion, but it also borders the Kazan Upland Natural Subregion to the east and the Lower Boreal Highland Natural Subregion to the west and around the northern base of the Caribou Mountains.

Elevations range from 150 m along the Hay River in the northwest to 650 m in the Cameron Hills. Gently undulating plains are the dominant topographic form. There are a few hummocky inclusions and areas of karst topography in the eastern portion. Organic deposits cover extensive areas in the western and central plains, with fine textured glaciolacustrine materials at lower elevations and till deposits in the Cameron Hills portion. Fine textured glaciolacustrine and sandy eolian materials are common in the eastern third where organic deposits are less extensive.

On upland areas, white and black spruce stands are typical, with mixedwood aspen–white spruce–black spruce stands on better drained soils along rivers and on local well-drained elevated areas. Much of the Natural Subregion is wetland, and is vegetated by open, stunted black spruce stands, often with permanently frozen Organic soils. The conventional reference site concept of deep, medium textured, well drained soils and their associated vegetation does not adequately fit most of the Northern Mixedwood Natural Subregion, where typical sites are wet and poorly drained, and soils are often permanently frozen.

Climate

The Northern Mixedwood Natural Subregion is characterized by short, warm, and on average dry summers and long, very cold winters. It is much drier than its neighbors, receiving only about 80 percent of the mean annual precipitation that falls on the Central Mixedwood and Lower Boreal Highlands Natural Subregions.

Moisture deficits may be significant in summer, especially on south-facing sites with coarse textured soils. The Alberta Climate Model (see Part 2 of this document) indicates that precipitation amounts are somewhat higher and potential moisture deficits (as indicated by the summer moisture index) somewhat lower in the higher elevation areas within the Cameron Hills.

The Northern Mixedwood Natural Subregion has the coldest winters of any boreal Natural Subregion. Even the higher elevation Boreal Subarctic Natural Subregion has slightly warmer average minimum temperatures, possibly because the coldest air associated with continental arctic and continental polar outbreaks tends to pool at lower elevations. Table 3-2 provides annual and seasonal climatic statistics and Figure 4-5.1 gives monthly temperature and precipitation patterns.

Vegetation

Vegetation in the Northern Mixedwood Natural Subregion has not been extensively studied, particularly north and east of the Caribou Mountains. Beckingham and Archibald (1996) grouped this Natural Subregion[7] together with the Central Mixedwood and Dry Mixedwood Natural Subregions. The vegetation patterns presented below and in Figure 4-5.8 are similar to those presented for the Central Mixedwood Natural Subregion; however, the reference site is not characteristic of the Natural Subregion.

Tamarack occurs occasionally on the extensive areas of poorly drained organic soils. (Photo: L. Allen)

Characteristic sites in the Northern Mixedwood Natural Subregion are vegetated by closed and open grown black spruce with some tamarack on extensive areas of poorly drained organic and mineral soils. Over the western two thirds of the area, aspen and black and white spruce forests often occur as islands on elevated areas and in linear forests that parallel stream channels. In the eastern portion, jack pine stands are common.

Black spruce is a persistent seral species on upland sites, and black spruce stands are an edaphic climax on poorly drained organic and mineral soils. Jack pine stands with lichen and bearberry understories are associated with very dry, coarse textured glaciofluvial or eolian deposits.

Common blueberry is often part of the understory in forests on coarse textured soils.
(Photo: L. Allen)

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[7] *Previously termed the Wetland Mixedwood Natural Subregion*

On coarse textured deposits where the water supply is somewhat greater, jack pine, aspen and white spruce occur in pure or mixed stands. Understories include bearberry, common blueberry, green alder, prickly rose, wild lily-of-the-valley and hairy wild rye.

Wild lily-of-the-valley can dominate patches in the understory of forests on well drained sites. (Photo: L. Allen)

On nutrient-poor sites, jack pine occurs with black spruce and understories of common Labrador tea, bog cranberry and feathermosses. Soils are typically Brunisols or weakly developed Gray Luvisols. These stand types probably occur most commonly in the eastern third of the Natural Subregion where there are eolian deposits.

Aspen stands and mixed stands of aspen, white and black spruce with understories of low bush cranberry, rose, green alder, Canada buffaloberry, hairy wild rye, bunchberry, wild sarsaparilla and dewberry occur on sites that are moderately moist and well drained.

Dewberry is a common understory species of moderately moist sites. (Photo: L. Allen)

Moderately moist forests often have wild sarsaparilla in the understory. (Photo: L. Allen)

These sites are usually associated with slight elevations or river terraces and valley walls and are considered reference sites for this Natural Subregion. Typical soils are fine textured Gray Luvisols, Brunisols and gleyed subgroups. White spruce and black spruce occur as pure and mixed forests with carpets of feathermoss. These develop on upland sites if stand-replacing fires do not occur for a sufficiently long period.

Balsam poplar, aspen, white and black spruce occur as pure or mixed stands with understories of red-osier dogwood, prickly rose, and a diverse array of herbaceous species in deciduous and mixedwood stands or a carpet of feathermosses and horsetails in coniferous stands. These stands are typically restricted to fluvial terraces. Soil textures are variable, and soils are Luvisols, Regosols or Gleysols.

Characteristic sites in the Northern Mixedwood Natural Subregion are species-poor black spruce fens and bogs with common and northern Labrador tea, peat mosses, feathermosses and lichens. Willow–dwarf birch shrublands with sedges and bluejoint, and treed, often patterned fens with tamarack, golden moss, and rich-site forbs and sedges are associated with better nutrient supplies. Organic soils are dominant, and permafrost is common under bogs. Species with a subarctic distribution such as northern Labrador tea become more common near the Alberta–Northwest Territories border, and species diversity tends to decline.

Geology and Geomorphology

The Northern Mixedwood Natural Subregion occurs entirely within the Great Slave Plain on the lowlands and on the higher elevation Bistcho Plain in the Cameron Hills. Gently undulating plains define the landscape. A few hummocky inclusions occur in the eastern portion of the area. The underlying bedrock ranges from Cretaceous marine shales in the western two thirds of the area to Devonian limestone, calcareous shales and gypsum formations in the east.

Organic deposits occupy about 50 percent of the Natural Subregion, with more than 80 percent organic terrain in parts of the western and central areas. Moderately fine textured glacial tills occur on uplands and underlie organic deposits in the Bistcho Plain and Ninishith Hills areas. Fine textured glaciolacustrine deposits underlie most of the western and central lowland plains.

The eastern third of the Natural Subregion is a mixture of glaciolacustrine and aeolian sands with organic deposits covering 10 to 60 percent of the area; there are also minor areas of glacial till. Organic accumulations are less common in the east because sands blanketing fissured and karst-modified limestone prevent the formation of perched water tables. Appendix 4 summarizes the proportional occurrence of landscape elements and parent materials in the Northern Mixedwood Natural Subregion.

Water and Wetlands

Many small lakes, of which Bistcho Lake is the largest, account for about 3 percent of the total area, and are mainly associated with glacial tills. The Hay and Slave Rivers drain to the Mackenzie River system. Wetlands are a major component of the western two thirds of the Natural Subregion, where they cover 60 to 80 percent of the area. They are dominated by treed bogs that often occur as peat plateaus underlain by permafrost. In the eastern third, wetlands cover 20 to 60 percent of the area, and are dominated by open fens with minor treed fen, bog and wet mineral soil components.

Soils

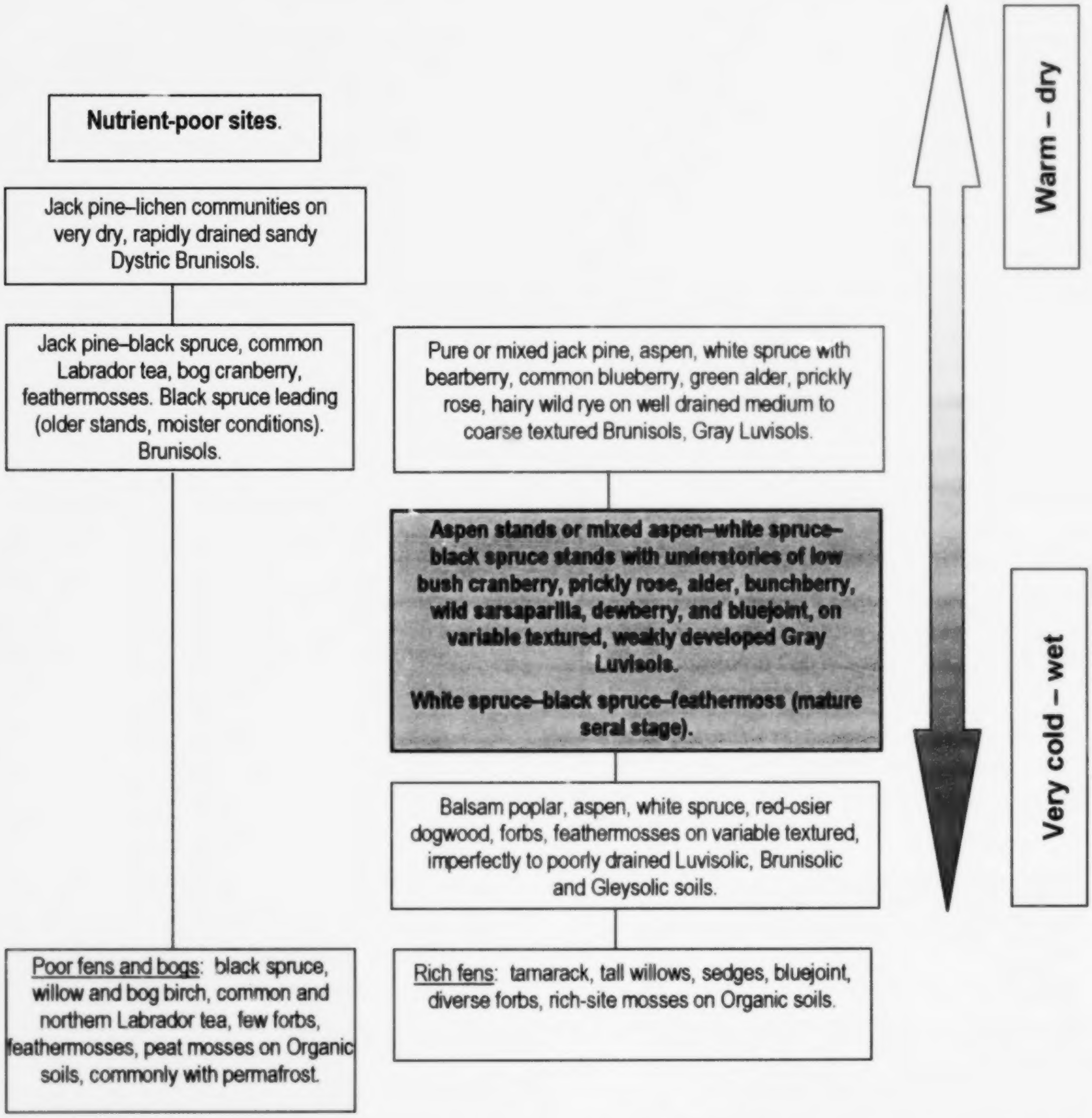
Fine textured mineral deposits cover about 30 percent of the area and are a complex of weakly developed Orthic and Gleyed Gray Luvisols (20%) and Gleyed Eutric Brunisols (10%). Sandy deposits, primarily in the eastern third, are a mix of Eluviated Dystric and Eutric Brunisols. Organic Cryosols and Mesisols are associated with bogs over about 30 percent of the total land area, and Typic, Terric and Fibric Mesisols are associated with fens over about 20 percent of the area. Orthic and Peaty Gleysols have developed on wet mineral soils on the remaining 10 percent of the area.

Appendix 7 summarizes the proportional occurrence of soil types in the Northern Mixedwood Natural Subregion.

Land Uses

Forest harvesting occurs only in the western part of the Northern Mixedwood Natural Subregion, mainly along rivers and streams where tree growth and productivity is sufficient to offset harvesting costs. Oil and gas activity is intensive, particularly in the Cameron Hills. Wood Buffalo National Park includes much of the central and eastern portions. Hunting, fishing and trapping provide subsistence and income to some residents.

Black spruce is commonly dominant in older stands, often with lichen prominent in the understory. (Photo D. Downing)



Nutrient-poor sites.

Jack pine–lichen communities on very dry, rapidly drained sandy Dystric Brunisols.

Jack pine–black spruce, common Labrador tea, bog cranberry, feathermosses. Black spruce leading (older stands, moister conditions). Brunisols.

Poor fens and bogs: black spruce, willow and bog birch, common and northern Labrador tea, few forbs, feathermosses, peat mosses on Organic soils, commonly with permafrost.

Pure or mixed jack pine, aspen, white spruce with bearberry, common blueberry, green alder, prickly rose, hairy wild rye on well drained medium to coarse textured Brunisols, Gray Luvisols.

Aspen stands or mixed aspen–white spruce–black spruce stands with understories of low bush cranberry, prickly rose, alder, bunchberry, wild sarsaparilla, dewberry, and bluejoint, on variable textured, weakly developed Gray Luvisols.

White spruce–black spruce–feathermoss (mature seral stage).

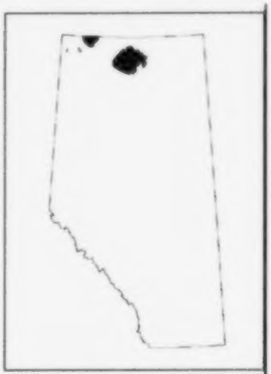
Balsam poplar, aspen, white spruce, red-osier dogwood, forbs, feathermosses on variable textured, imperfectly to poorly drained Luvisolic, Brunisolic and Gleysolic soils.

Rich fens: tamarack, tall willows, sedges, bluejoint, diverse forbs, rich-site mosses on Organic soils.

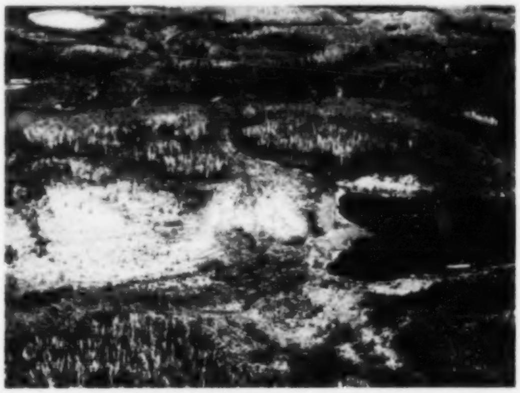
Figure 4-5.8. Common ecosystems arranged along environmental gradient, Northern Mixedwood Natural Subregion. (*Reference site is in blue-shaded box in boldface; characteristic site is in yellow-shaded box.*)

4.5.8 Boreal Subarctic Natural Subregion

Theme



Elevated plateaus in far northern Alberta, open black spruce bogs with frozen Organic soils, short, cool summers and long, very cold winters are unique characteristics of the Boreal Subarctic Natural Subregion. Many subarctic bird, insect and plant species that are common in the Northwest Territories occur in Alberta only in this Natural Subregion.



Overview (Photo: D. Vujnovic)

Total area: 11,823 km² (3% of Boreal Forest Natural Region).

Average elevation: 825 m (range 575-1000 m.

Key Features

- Higher elevations in the Caribou Mountains and Cameron Hills, with climate conditions that restrict plant growth and produce extensive areas of frozen Organic soils.
- Open black spruce stands, peatland complexes and permafrost terrain.

Bog bilberry is characteristic of this subregion.
(Photo: L. Allen)

General Description

The Boreal Subarctic Natural Subregion occurs on high-elevation plateaus in the Cameron Hills and Caribou Mountains. It is completely surrounded by the Lower Boreal Highlands Natural Subregion except for a very small area in the Cameron Hills where the Northern Mixedwood Natural Region lies adjacent. Elevations range from 575 m to over 1000 m in the western Caribou Mountains.

Landscapes are primarily undulating and rolling plateaus and highlands, with extensive low-lying, poorly drained areas. Most of the area is covered by organic deposits; fine textured glacial till deposits are also common. Fires are frequent and open, stunted black spruce stands with shrub, moss and lichen understories occur across large areas, underlain by frozen, poorly drained organic materials. Moderately well drained upland areas occupy minor areas of the Natural Subregion, and a variety of upland forests may occur, dominated by pure or mixed aspen, white spruce, black spruce, Alaska birch and lodgepole pine.

The conventional reference site concept of deep, medium textured, well drained soils and their associated vegetation does not adequately fit most of the Boreal Subarctic Natural Subregion, where typical sites are wet, poorly drained and very cold.

Climate

The Boreal Subarctic Natural Subregion is the coldest boreal Natural Subregion, having the lowest mean annual temperature. Summers are short, cool and moist, and growing degree-day accumulations are markedly lower than in other boreal Natural Subregions. Winters are long and very cold.

This Natural Subregion receives more of its total annual precipitation during the September to March period (mainly as snow) than any other boreal Natural Subregion. Low temperatures, low sun angles and insulating effect of deep, water-saturated organic and moss layers combine to produce thermal conditions that contribute to permafrost formation and severely restrict plant growth. Table 3-2 provides annual and seasonal climatic statistics, and Figure 4-5.1 gives monthly temperature and precipitation patterns.

Vegetation

Few detailed vegetation studies have been conducted in the Boreal Subarctic Natural Subregion. Beckingham and Archibald (1996) produced a first approximation of vegetation communities based on less than 100 plots. Strong and Leggat (1992) summarized three earlier studies in the Caribou Mountains and Cameron Hills in their description of the Boreal Subarctic Ecoregion. The following summary and Figure 4.5-9 are a synthesis of the notes of the Natural Regions and Subregions review committee and the above two reports.

Open black spruce, lodgepole pine[8] or mixed lodgepole pine–aspen stands with lichen understories are associated with very dry, coarse textured glaciofluvial deposits and Brunisolic soils, and are uncommon. Pure or mixed stands of aspen, lodgepole pine, white and black spruce and Alaska birch with sparse, species-poor understories of prickly rose, bog cranberry and stair-step feathermoss develop on variable-textured till materials that are moderately well to imperfectly drained and moderately well supplied with nutrients. Soils are usually Luvisols.

Nutrient-poor upland sites are typically forested by black spruce-dominated stands with feathermoss understories. Lichens may dominate the understory in more open stands. Common Labrador tea and bog cranberry are typical shrubs, and lodgepole pine may be present with variable cover in the tree canopy. Moist, rich sites are very uncommon, and are associated with minor fluvial deposits in stream valleys. In such areas, aspen, Alaska birch and white spruce occur with river alder, prickly rose, meadow and common horsetails, and feathermosses.

Characteristic sites in the Boreal Subarctic Natural Subregion are species-poor, open black spruce bogs and fens with common and northern Labrador tea, bog bilberry, cloudberry, reindeer lichen, peat mosses and feathermosses. Organic soils are dominant and permafrost is common. In permafrost collapse scars, where the permafrost has melted, sheathed cotton grass–midway peat moss bogs are common.

Cloudberry is a common bog species. (Photo: L. Allen)

Slow-moving drainages through the bogs are frequent. Typically, peat mosses tolerant of high water tables dominate the wettest sites in the centre of the channel, grading into drier peat moss edges and a linear community of leatherleaf hummocks and peat moss hollows.

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[8] *Or lodgepole pine-jack pine hybrids*

Fires are frequent and older stands are uncommon. Where they do develop, they tend to be closed black spruce forests with a continuous feathermoss carpet and very few vascular understory species.

The harsh, cold growing conditions typical of characteristic sites are evidenced by the presence of subarctic species like northern Labrador tea and bog bilberry. The generally low species diversity of all upland and wetland sites compared to other Natural Subregions also reflects the rigorous climate.

Geology and Geomorphology

The Boreal Subarctic Natural Subregion is confined to the undulating and rolling upper plateau surfaces of the Caribou Mountains and the Cameron Hills in the Northern Alberta Uplands. The underlying bedrock is mainly Cretaceous marine shales with some sandstones in the Caribou Mountains. Organic deposits cover about 60 percent of the area, but this proportion varies locally from 50 to 80 percent. Fine textured glacial tills occupy most of the remaining area; there are occasional glaciofluvial and residual materials. Appendix 4 summarizes the proportional occurrence of landscape elements and parent materials in the Boreal Subarctic Natural Subregion.

Water and Wetlands

About 2 percent of the total area in the Boreal Subarctic Natural Subregion is occupied by water. Drainage is largely internal, but a few streams flow out of the Natural Subregion. The main lakes are Margaret and Wentzel in the Caribou Mountains, and Thurston and Beatty Lakes in the Cameron Hills.

Wetlands cover about 65 percent of this Natural Subregion, but can be over 80 percent in some areas. They are essentially a peat plateau complex of open or treed bogs with permafrost and open and wooded fens. Permafrost collapse scars are a diagnostic feature. Wet mineral and shallow peat soils also occur.

Soils

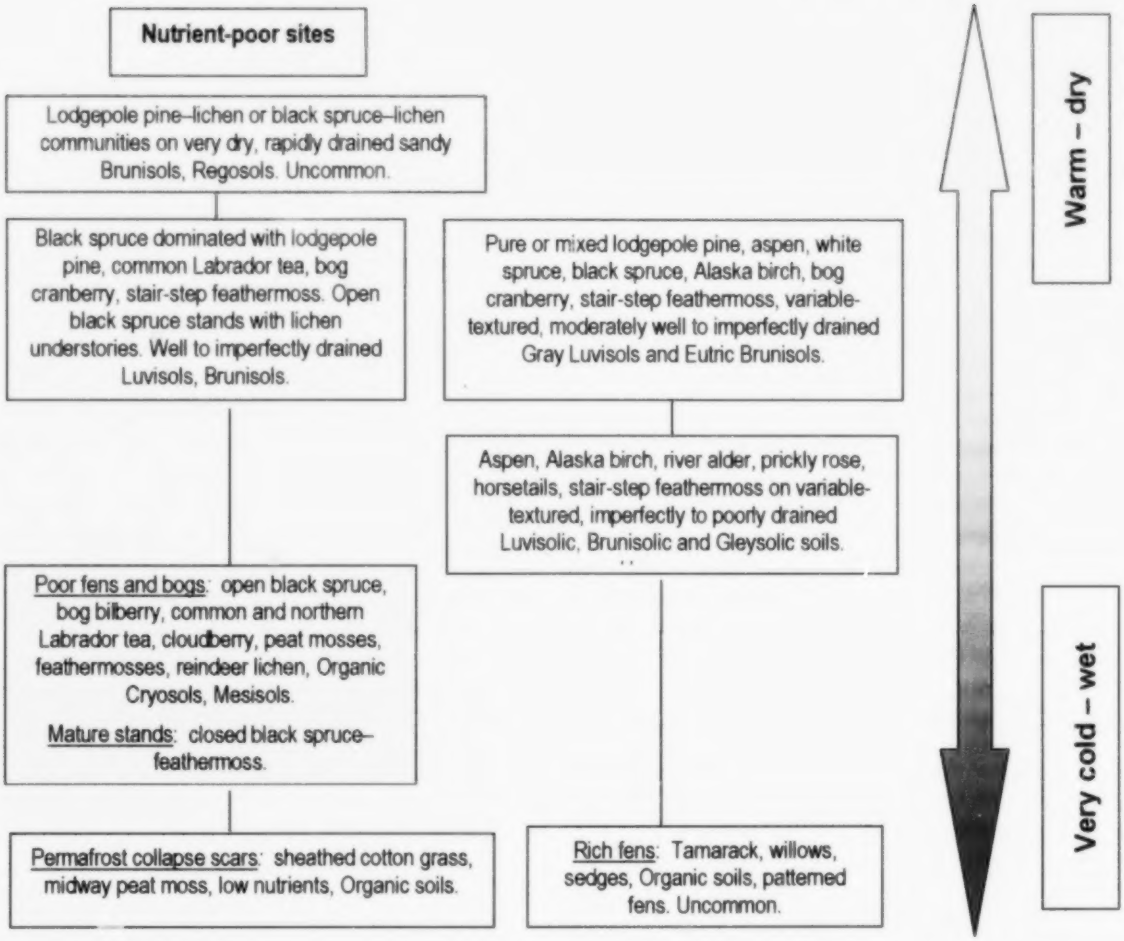
Mineral soils are weakly developed in this cold, moist environment. They are a complex of thin Orthic and Gleyed Gray Luvisols over 25 percent of the area, with Eluviated and Gleyed Eutric Brunisols over 10 percent of the area. Orthic and Peaty Gleysols are minor components (about 10 percent of the total area), and are associated with wetlands.

Organic soils are a mixture of Organic Cryosols over 35 percent of the Natural Subregion and Typic Mesisols over about 20 percent. Terric and Fibric Subgroups are common. Appendix 7 summarizes the proportional occurrence of soil types in the Boreal Subarctic Natural Subregion.

Land Uses

Oil and gas activity is locally intensive, particularly in the Cameron Hills. Some recreational fly-in fishing occurs in the larger lakes of the Caribou Mountains, but poor access and low productivity restrict hunting, trapping and other subsistence and recreational activities. There is no forestry or agricultural potential.

A characteristic species-poor, open black spruce bog with common and northern Labrador tea and a significant reindeer lichen component.
(Photo: L. Allen)



Lodgepole pine–lichen or black spruce–lichen communities on very dry, rapidly drained sandy Brunisols, Regosols. Uncommon.

Black spruce dominated with lodgepole pine, common Labrador tea, bog cranberry, stair-step feathermoss. Open black spruce stands with lichen understories. Well to imperfectly drained Luvisols, Brunisols.

Pure or mixed lodgepole pine, aspen, white spruce, black spruce, Alaska birch, bog cranberry, stair-step feathermoss, variable-textured, moderately well to imperfectly drained Gray Luvisols and Eutric Brunisols.

Aspen, Alaska birch, river alder, prickly rose, horsetails, stair-step feathermoss on variable-textured, imperfectly to poorly drained Luvisolic, Brunisolic and Gleysolic soils.

Poor fens and bogs: open black spruce, bog bilberry, common and northern Labrador tea, cloudberry, peat mosses, feathermosses, reindeer lichen, Organic Cryosols, Mesisols.

Mature stands: closed black spruce–feathermoss.

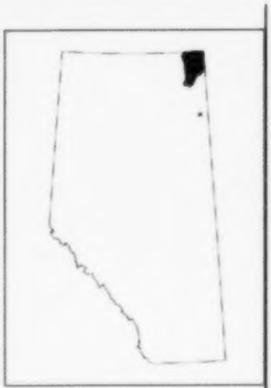
Permafrost collapse scars: sheathed cotton grass, midway peat moss, low nutrients, Organic soils.

Rich fens: Tamarack, willows, sedges, Organic soils, patterned fens. Uncommon.

Figure 4-5.9. Common ecosystems arranged along environmental gradient, Boreal Subarctic Natural Subregion. (*Characteristic site is in yellow-shaded box.*)

4.6 CANADIAN SHIELD NATURAL REGION/KAZAN UPLAND NATURAL SUBREGION

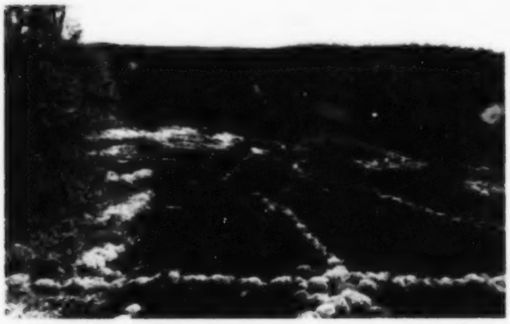
Regional/Subregional Theme



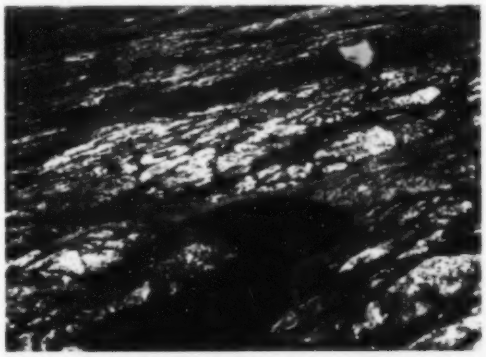
Sparsely vegetated granite bedrock exposures and coarse glacial deposits, hundreds of small lakes, short, warm summers and very cold winters are unique features of the Kazan Upland Natural Subregion in the far northeast, the only area in Alberta on the Canadian Shield.

- Total area: 9719 km^2 (1.5% of province).
- Average elevation: 275 m (range 150-400 m).

Rocky cliffs provide habitat for many species, including nesting habitat for birds such as ravens. (Photo: D. Vujnovic)



Lichen dominates on open rocks. (Photo: D. Vujnovic)



Overview of Kazan Upland Natural Subregion. (Photo: A. Landals)

General Description

The Canadian Shield Natural Region has only one Natural Subregion, the Kazan Upland. The following discussion of the Kazan Upland Natural Subregion applies to the Canadian Shield Natural Region as well. The Kazan Upland Natural Subregion occurs in the far northeastern corner of Alberta. The main area lies north of Lake Athabasca. It is bordered on the east and north by the Alberta–Saskatchewan and Alberta–Northwest Territories boundaries, respectively, on the west by the Slave River, and on the south by Lake Athabasca. There is a small outlier east of the Athabasca River between Fort McMurray and Fort Chipewyan embedded within the Athabasca Plain Natural Subregion. Elevations range from about 150 m to over 400 m. Extensive outcrops of Precambrian bedrock, the westernmost edge of the Canadian Shield, define the limits of the Kazan Upland Natural Subregion; on average, 60 percent of the landscape is exposed bedrock. Topography is hummocky to rolling, with local relief of up to 50 m. Parent materials are ice-scoured bedrock and coarse textured glacial drift. Bedrock barrens are interspersed with "pocket" communities vegetated by lichens, mosses and drought-tolerant ferns.

Open jack pine, aspen and birch stands occur where the soil is sufficiently deep. Acidic bogs and poor fens occur adjacent to the many small lakes and in low spots on the more subdued terrain in the western part of the Natural Subregion. The conventional reference site concept of deep, medium textured, well drained soils and associated vegetation does not adequately fit most of the Kazan Upland Natural Subregion. Characteristic sites are rocky exposures or dry, rapidly drained coarse glacial deposits.

Climate

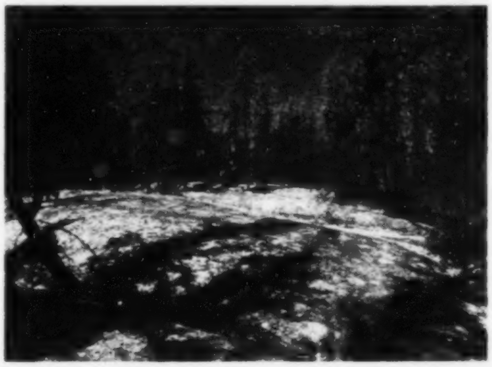
The Kazan Upland Natural Subregion is characterized by short summers in which July is the warmest month, and the coldest winters of any Natural Subregion in Alberta, reflecting the influence of continental polar and continental arctic weather systems. July is the month of maximum precipitation, and winter snowfalls account for about 40 percent of the total annual precipitation. Figure 4-6.1 and Table 3-2 provide monthly and annual climate data summaries.

The Alberta Climate Model (see Part 2) indicates the Kazan Upland Natural Subregion receives about the same annual precipitation as the Dry Mixedgrass Natural Subregion, and has a potential summer moisture deficit (summer moisture index) comparable to that of the Northern Fescue Natural Subregion. The prevalence of rock barrens and well to rapidly drained glacial deposits, together with low rainfalls, produce conditions that are favorable for nonvascular and vascular plants that are adapted to dry conditions.

Vegetation

Vegetation in the Kazan Upland Natural Subregion is strongly influenced by the distribution and acidic characteristics of granitic bedrock exposures and well to rapidly drained glacial drift, and by frequent fires. Beckingham and Archibald (1996) produced a general description of vegetation communities based on limited plot data that included both the Athabasca Plain and the Kazan Upland Natural Subregion. Wallis and Wershler (1984) described five upland and three wetland types from the east portion of the Natural Subregion. The following discussion and Figure 4.6-2 are a summary of these two reports and the notes of the Natural Regions and Subregions review committee.

Communities associated with dry rock barrens are widespread. Although species diversity is low in any given locale, the variety of habitat types results in high species diversity across the barrens. Various lichen communities occupy south-facing and steep rock faces and slopes, and most are found only in the Kazan Upland. "Pocket" communities grow in rock crevices and in sheltered locations where mineral soil has accumulated and moisture conditions are better. Stunted jack pine and Alaska birch form open stands with a sparse understory of bearberry, ground juniper, bog cranberry, and a variety of drought-tolerant ferns and other herbs, mosses and lichens.



Lichen communities occupy rock faces and slopes, and sparse jack pine communities grow in rock crevices and in sheltered locations. (Photo: D. Vujnovic)

Coarse textured, rapidly drained and dry sandy or gravelly soils support more vigorous jack pine growth. The driest sites are vegetated by open jack pine stands with a patchy carpet of lichens on the forest floor. Moister sites support more diverse understories of green alder, common blueberry, bearberry, common Labrador tea, Canada buffaloberry, bunchberry, other herbs and feathermosses. Aspen, Alaska birch and black spruce are locally common in places. Brunisols are common soils. Moist communities of aspen, balsam poplar, Alaska birch, white spruce and a diverse and lush shrub and forb understory develop in bands adjacent to wetlands and along lakes.

Bog communities are the dominant wetland type. Black spruce forms open-to-dense stands with an understory of common Labrador tea, leatherleaf, bog cranberry, cloudberry and peat moss on Organic soils. Permafrost is discontinuous but widespread. Nutrient-rich wetlands typically have open forests of tamarack, willow, dwarf birch, sedges and rich-site mosses. Marshes can be locally extensive in sheltered lake bays or along creek channels, and are dominated by water and small bottle sedge, bulrushes, and in deeper water, pondweeds.

Geology and Geomorphology

The Kazan Upland Natural Subregion lies along the western edge of the Canadian Shield. The terrain is hummocky to rolling with relief up to 50 m.

Sparsely vegetated granite bedrock exposures.
(Photo: D. Vujnovic)

The bedrock is composed of Aphebian and Archaen granitoids. Surficial features include about 45 percent glacially scoured rock, about 40 percent sandy and gravelly ice-contact glacial drift, and about 15 percent organic accumulations in low-lying areas. Appendix 4 summarizes the proportional occurrence of landscape elements and parent materials in the Kazan Upland Natural Subregion.

Water and Wetlands

Dozens of small lakes occupy about 10 percent of the Kazan Upland Natural Subregion, the largest being Cornwall, Colin, Charles, Wylie and Andrew Lakes. A few small streams drain into the Slave River. Wetlands are most common in the lower relief western half of the Natural Subregion, and cover about 20 percent of the total area. Treed poor fens and bogs on Organic soils are the most common wetland type. Shrubby fens and marshes on Organic and wet mineral soils also occur.

Soils

Nonsoils (e.g., bedrock outcrops) occur across about half the area. Surficial deposits between bedrock outcrops are mainly coarse and acidic. Soils on these materials are predominantly eluviated Dystric Brunisols with associated Orthic, Gleyed and Lithic Subgroups, the latter on very thin deposits over bedrock. Wetlands are a complex of Typic and Fibric Mesisols, many with Terric Subgroups. Peaty Gleysols also occur. Appendix 7 summarizes the proportional occurrence of soil types in the Kazan Upland Natural Subregion.

Land Uses

Hunting, fishing and trapping provide subsistence and income to some residents. There are recreational fishing camps on some of the lakes. Forestry and mining are locally important in the Fort Chipewyan area.

Wildlife Habitats and Populations

Lakes, wetlands, upland forests, rocky cliffs and islands provide habitat for a variety of wildlife species. Although the length and severity of winters in this area limits the number of resident avian species, migratory spring and summer avifauna populations are diverse, reflecting habitat types. However, population densities are lower than in areas further south. Sandy and muddy shoreflats are feeding areas for Sandhill Cranes, waterfowl, migratory and breeding shorebirds and other species. Waterfowl use the rock platforms along the lakeshore for loafing, and rock cliffs furnish nesting sites for Peregrine Falcons. Some rocky islets provide nesting habitat for species including colonial birds such as Bonaparte's Gull, Herring Gull, California Gull and Common Tern. Bald Eagles and Osprey nest along lakeshores and other suitable habitats in the Natural Region.

Wetland habitats support populations of Common Loon, Lesser Scaup, Bufflehead, Bonaparte's Gull, Spotted Sandpiper, Alder Flycatcher, Palm Warbler, Rusty Blackbird, Red-winged Blackbird and Lincoln's Sparrow. Pine forests provide habitat for Common Nighthawk, Gray Jay, Common Raven, Boreal Chickadee, American Robin, Hermit Thrush and Dark-eyed Junco.

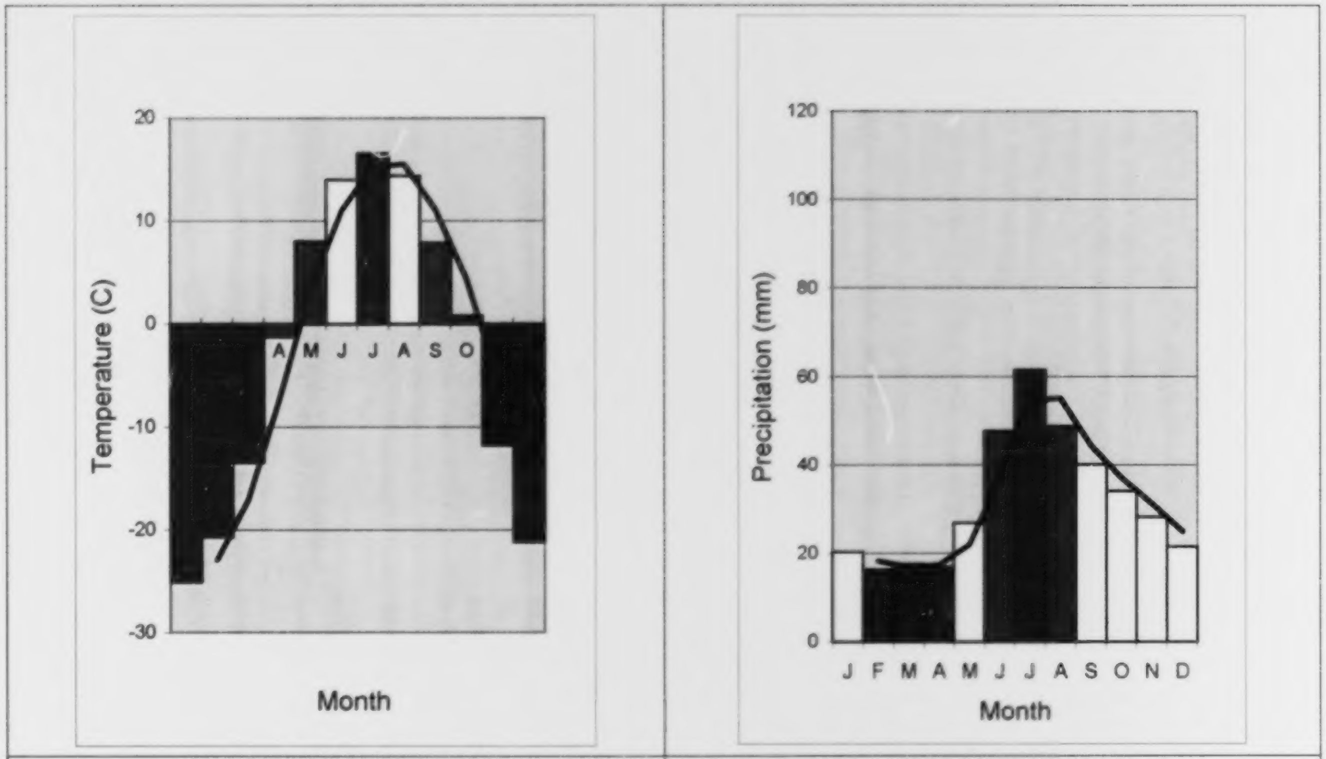
Mammals include moose, American beaver, muskrat, mink, water shrew, arctic shrew, least chipmunk, river otter, Canada lynx and gray wolf. Pine forests are home to red squirrel, snowshoe hare, Canada lynx and red fox. Winter visitors from the Northwest Territories include the Willow Ptarmigan (common and widespread), the barren ground subspecies of the caribou (localized, historical occurrences), and arctic fox (localized occurrences).

Amphibians reported for the Kazan Upland Natural Subregion include the wood frog, boreal chorus frog, leopard frog and Canadian toad. Northern pike, walleye, lake whitefish and lake trout are common fish species.

Notable Features

- *Canadian Shield*: The Kazan Upland Natural Subregion is the only occurrence of Precambrian shield bedrock exposures in Alberta.
- *Mew Gull* and *Semipalmated Plover* are at the southern periphery of their breeding range, a range that extends well into the Northwest Territories. Documented breeding evidence for both these species has been reported for only a few locations in northeastern Alberta.
- The *Woodman–Alexander Lakes* area constitutes a regionally significant waterfowl staging site. Woodman Lake has hosted the largest concentration of staging Greater Scaup ever reported from Alberta.
- *Fish*: The only verified population of the shortjaw cisco in Alberta is in Barrow Lake, located north of Lake Athabasca and east of the Slave River. It is listed as "Threatened" by the Government of Alberta and COSEWIC.
- *Other fauna*: The Kazan Upland Natural Subregion has a number of significant invertebrate species that are out of range, rare, or are the first records for this part of Alberta.
- *Flora*: The shores of Lake Athabasca are at the edge of the main extent of the shield in Alberta, and present habitats for several plant species not found elsewhere in Alberta such as American dune grass and Greenland wood-rush.

The shores of Lake Athabasca provide habitat for several plant species not sound elsewhere in Alberta, such as American dune grass. (Photo: L. Allen)



Kazan Upland Natural Subregion
Mean Monthly Temperature (MAT –2.6°C)

Kazan Upland Natural Subregion
Mean Monthly Precipitation (MAP 380 mm)

Figure 4-6.1. Kazan Upland Natural Subregion climate data summaries. (*Refer to footnotes in Figures 3-8 and 3-11 for color scheme explanations. MAP = Mean Annual Precipitation, MAT = Mean Annual Temperature.*)

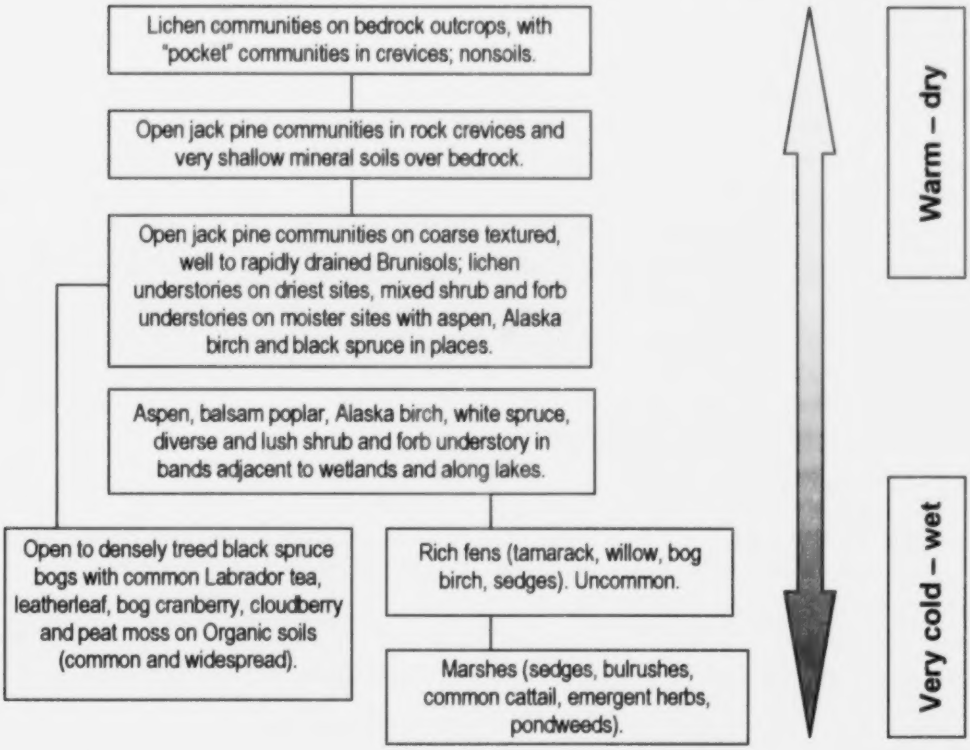

Lichen communities on bedrock outcrops, with "pocket" communities in crevices; nonsoils.
Open jack pine communities in rock crevices and very shallow mineral soils over bedrock.
Open jack pine communities on coarse textured, well to rapidly drained Brunisols; lichen understories on driest sites, mixed shrub and forb understories on moister sites with aspen, Alaska birch and black spruce in places.
Aspen, balsam poplar, Alaska birch, white spruce, diverse and lush shrub and forb understory in bands adjacent to wetlands and along lakes.
Open to densely treed black spruce bogs with common Labrador tea, leatherleaf, bog cranberry, cloudberry and peat moss on Organic soils (common and widespread).
Rich fens (tamarack, willow, bog birch, sedges). Uncommon.
Marshes (sedges, bulrushes, common cattail, emergent herbs, pondweeds).
Warm – dry
Very cold – wet

Figure 4-6.2. Common ecosystems arranged along environmental gradient, Kazan Upland Natural Subregion. (*Characteristic sites are in yellow-shaded boxes.*)

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NATURAL REGIONS AND SUBREGIONS OF ALBERTA

APPENDICES

APPENDIX 1. PLANT SPECIES LIST

For the reader's convenience, the following list is sorted by both scientific and common name

Vascular plant nomenclature follows Moss (1983). Scientific names followed by (a) have been updated as noted in *Flora of North America* (Flora of North America Editorial Committee 1993-2000) and Douglas et al. (1998, 1999-2002). Scientific names followed by (b) have been updated as noted in Aiken and Darbyshire (1990). Nonvascular plant nomenclature, specifically for mosses, follows Ireland et al. (1987) and Schofield (1992). Common plant names follow the *Alberta Plants and Fungi – Master Species List and Species Group Checklists* (Alberta Environmental Protection 1993).

Abies balsamea (L.) Mill.	balsam fir
Abies bifolia A. Murr. (a)	subalpine fir
Actaea rubra (Ait.) Willd.	red and white baneberry
Agropyron dasystachyum (Hook.) Scribn.	northern wheat grass
Agropyron smithii Rydb.	western wheat grass
Agropyron spicatum (Pursh) Scribn. & Smith	bluebunch wheat grass
Agropyron trachycaulum (Link) Malte	slender wheat grass
Alaska birch	**Betula neoalaskana** Sargent
Alnus tenuifolia Nutt.	river alder
Alnus viridis (Vill.) Lam.&DC. (a)	green alder
alpine fescue	**Festuca brachyphylla** Schultes
Amelanchier alnifolia Nutt.	saskatoon
American dune grass	**Elymus mollis** Trin.
Anemone patens L.	prairie crocus
Aralia nudicaulis L.	wild sarsaparilla
Arctostaphylos uva-ursi (L.) Spreng.	common bearberry
Artemisia campestris L.	plains wormwood
Artemisia cana Pursh	silver sagebrush
Artemisia frigida Willd.	pasture sagewort
Artemisia ludoviciana Nutt.	prairie sagewort
aspen	**Populus tremuloides** Michx.
awned sedge	**Carex atherodes** Spreng.
balsam fir	Abies **balsamea** (L.) Mill.
balsam poplar	**Populus balsamifera** L.
Barratt's willow	**Salix barrattiana** Hook.
basket willow	Salix **petiolaris** J.E. Smith
beaked hazelnut	**Corylus cornuta** Marsh.
beaked sedge	**Carex rostrata** Stokes

beaked willow	**Salix bebbiana** Sarg.
bear-grass	**Xerophyllum tenax** (Pursh) Nutt.
Berberis repens Lindl.	creeping mahonia
Betula glandulosa Michx.	bog birch
Betula neoalaskana Sargent	Alaska birch
Betula papyrifera Marsh.	white birch
Betula pumila L.	dwarf birch
black alpine sedge	**Carex nigricans** C.A. Meyer
black spruce	**Picea mariana** (Mill.) BSP.
blue grama	**Bouteloua gracilis** (HBK.) Lag.
bluebunch fescue	**Festuca idahoensis** Elmer
bluebunch wheat grass	**Agropyron spicatum** (Pursh) Scribn. & Smith
bluejoint	**Calamagrostis canadensis** (Michx.) Beauv.
bog bilberry	**Vaccinium uliginosum** L.
bog birch	**Betula glandulosa** Michx.
bog cranberry	**Vaccinium vitis-idaea** L.
bog-sedge	**Kobresia myosuroides** (Vill.) Fiori & Paol.
Bouteloua gracilis (HBK.) Lag.	blue grama
bracted honeysuckle	**Lonicera involucrata** (Richards.) Banks
brittle prickly-pear	**Opuntia fragilis** (Nutt.) Haw.
buckbrush	**Symphoricarpos occidentalis** Hook.
bulrushes	**Scirpus** spp.
bunchberry	**Cornus canadensis** L.
Calamagrostis canadensis (Michx.) Beauv.	bluejoint
Calamagrostis rubescens Buckl.	pine reed grass
Calamovilfa longifolia (Hook.) Scribn.	sand grass
California oat grass	**Danthonia californica** Boland
Canada buffaloberry	**Shepherdia canadensis** (L.) Nutt.
Carex aquatilis Wahlenb.	water sedge
Carex atherodes Spreng.	awned sedge
Carex nigricans C.A. Meyer	black alpine sedge
Carex rostrata Stokes	beaked sedge
Carex siccata Dewey	hay sedge
Carex utriculata Boott (a)	small bottle sedge
Carex spp.	sedges
Cassiope mertensiana (Bong.) D. Don	western mountain-heather
Cassiope tetragona (L.) D. Don	white mountain-heather

Chamaedaphne calyculata (L.) Moench	leatherleaf
choke cherry	**Prunus virginiana** L.
Cladina mitis (Sandst.) Hale & W. Culb.	reindeer lichen
cloudberry	**Rubus chamaemorus** L.
common bearberry	**Arctostaphylos uva-ursi** (L.) Spreng.
common cattail	**Typha latifolia** L.
common fireweed	**Epilobium angustifolium** L.
common horsetail	**Equisetum arvense** L.
common Labrador tea	**Ledum groenlandicum** Oeder
common tall manna grass	**Glyceria grandis** S. Wats. ex A. Gray
common wild rose	**Rosa woodsii** Lindl.
Cornus canadensis L.	bunchberry
Cornus stolonifera Michx.	red-osier dogwood
Corylus cornuta Marsh.	beaked hazelnut
cow parsnip	**Heracleum maximum** Bartr. (a)
Crataegus douglasii Lindl.	Douglas hawthorn
Crataegus rotundifolia Moench	round-leaved hawthorn
cream-colored vetchling	**Lathyrus ochroleucus** Hook.
creeping juniper	**Juniperus horizontalis** Moench
creeping mahonia	**Berberis repens** Lindl.
crowberry	**Empetrum nigrum** L.
Danthonia californica Boland	California oat grass
Danthonia parryi Scribn.	Parry oat grass
Deschampsia cespitosa (L.) Beauv.	tufted hair grass
devil's-club	**Oplopanax horridum** (Sm.) Miq.
dewberry	**Rubus pubescens** Raf.
Douglas hawthorn	**Crataegus douglasii** Lindl.
Douglas fir	**Pseudotsuga menziesii** (Mirb.) Franco
Drummond's willow	**Salix drummondiana** Barr. ex Hook.
Dryas octopetala L.	white mountain avens
dwarf birch	**Betula pumila** L.
dwarf bramble	**Rubus pedatus** J.E. Smith
dwarf raspberry	**Rubus arcticus** L.
Elaeagnus commutata Bernh. ex Rydb.	silverberry
Eleocharis spp.	spike-rush
Elymus mollis Trin.	American dune grass
Empetrum nigrum L.	crowberry

Engelmann spruce	**Picea engelmannii** Parry ex Engelm.
Epilobium angustifolium L.	common fireweed
Equisetum arvense L.	common horsetail
Equisetum fluviatile L.	swamp horsetail
Equisetum pratense Ehrh.	meadow horsetail
Equisetum spp.	horsetails
Eriophorum vaginatum L.	sheathed cotton grass
Erythronium grandiflorum Pursh	glacier lily
false azalea	**Menziesia ferruginea** J.E. Smith
fescue grasses	**Festuca** spp.
Festuca brachyphylla Schultes	alpine fescue
Festuca campestris Rydberg (b)	mountain rough fescue
Festuca hallii (Vasey) Piper (b)	plains rough fescue
Festuca idahoensis Elmer	bluebunch fescue
Festuca saximontana Rydb.	Rocky Mountain fescue
Festuca spp.	fescue grasses
flat-leaved willow	**Salix planifolia** Pursh
Galium boreale L.	northern bedstraw
Gentiana aquatica L.	marsh gentian
Geranium richardsonii Fisch. & Trautv..	wild white geranium
Geranium viscosissimum Fisch. & Mey.	sticky purple geranium
Geum triflorum Pursh	three-flowered avens
glacier lily	**Erythronium grandiflorum** Pursh
Glyceria grandis S. Wats. ex A. Gray	common tall manna grass
golden bean	**Thermopsis rhombifolia** (Nutt.) Richards.
golden moss	**Tomenthypnum nitens** (Hedw.) Loeske
green alder	**Alnus viridis** (Vill.) Lam.&DC. (a)
grouseberry	**Vaccinium scoparium** Leiberg
hairy wild rye	**Leymus innovatus** (Beal) Pilger (a)
hare-footed locoweed	**Oxytropis lagopus** Nutt.
hay sedge	**Carex siccata** Dewey
Heracleum maximum Bartr. (a)	cow parsnip
horsetails	**Equisetum** spp.
Hudsonia tomentosa Nutt.	sand heather
Hylocomium splendens (Hedw.) B.S.G.	stair-step moss *(Feathermoss)*
jack pine	**Pinus banksiana** Lamb.
June grass	**Koeleria macrantha** (Ledeb.) J.A. Schultes

junipers	**Juniperus** spp.
Juniperus horizontalis Moench	creeping juniper
Juniperus spp.	junipers
knight's plume moss *(Feathermoss)*	**Ptilium crista-castrensis** (Hedw.) De Not.
Kobresia myosuroides (Vill.) Fiori & Paol.	bog-sedge
Koeleria macrantha (Ledeb.) J.A. Schultes	June grass
Larix laricina (Du Roi) K. Koch	tamarack
Larix lyallii Parl.	subalpine larch
Lathyrus ochroleucus Hook.	cream-colored vetchling
Lathyrus venosus Muhl.	purple peavine
leatherleaf	**Chamaedaphne calyculata** (L.) Moench
Ledum groenlandicum Oeder	common Labrador tea
Ledum palustre L.	northern Labrador tea
Leymus innovatus (Beal) Pilger (a)	hairy wild rye
limber pine	**Pinus flexilis** James
Linnaea borealis L.	twinflower
Linum lewisii Pursh	wild blue flax
lodgepole pine	**Pinus contorta** Loudon
lodgepole x jack pine	**Pinus contorta** x **banksiana**
Lonicera involucrata (Richards.) Banks	bracted honeysuckle
low bilberry	**Vaccinium myrtillus** L.
low-bush cranberry	**Viburnum edule** (Michx.) Raf.
Lupinus argenteus Pursh	silvery perennial lupine
Maianthemum canadense Desf.	wild lily-of-the-valley
marsh gentian	**Gentiana aquatica** L.
meadow horsetail	**Equisetum pratense** Ehrh.
Menziesia ferruginea J.E. Smith	false azalea
midway peat moss	**Sphagnum magellanicum** Brid.
moss phlox	**Phlox hoodii** Richards.
mountain rough fescue	**Festuca campestris** Rydberg (b)
mountain-lover	**Pachistima myrsinites** (Pursh) Raf.
needle grasses	**Stipa** spp.
needle-and-thread	**Stipa comata** Trin. & Rupr.
northern bedstraw	**Galium boreale** L.
northern Labrador tea	**Ledum palustre** L.
northern rice grass	**Oryzopsis pungens** (Torr.) A.S. Hitchc.
northern wheat grass	**Agropyron dasystachyum** (Hook.) Scribn.

Oplopanax horridum (Sm.) Miq.	devil's-club
Opuntia fragilis (Nutt.) Haw.	brittle prickly-pear
Oryzopsis asperifolia Michx.	white-grained mountain rice grass
Oryzopsis pungens (Torr.) A.S. Hitchc.	northern rice grass
Oxytropis lagopus Nutt.	hare-footed locoweed
Pachistima myrsinites (Pursh) Raf.	mountain-lover
Parry oat grass	**Danthonia parryi** Scribn.
pasture sagewort	**Artemisia frigida** Willd.
peat mosses	**Sphagnum** spp.
Pedicularis sudetica Willd.	purple rattle
Phlox hoodii Richards.	moss phlox
Phyllodoce empetriformis (Smith) D. Don	red heather
Phyllodoce glanduliflora (Hook.) Coville	yellow heather
Picea engelmannii Parry ex Engelm.	Engelmann spruce
Picea glauca (Moench) Voss	white spruce
Picea mariana (Mill.) BSP.	black spruce
pine reed grass	**Calamagrostis rubescens** Buckl.
Pinus albicaulis Engelm.	whitebark pine
Pinus banksiana Lamb.	jack pine
Pinus contorta Loudon	lodgepole pine
Pinus contorta x **banksiana**	lodgepole x jack pine
Pinus flexilis James	limber pine
plains cottonwood	**Populus deltoides** Marsh.
plains rough fescue	**Festuca hallii** (Vasey) Piper (b)
plains wormwood	**Artemisia campestris** L.
Pleurozium schreberi (Brid.) Mitt.	Schreber's moss (*Feathermoss*)
pondweeds	**Potamogeton** spp.
Populus balsamifera L.	balsam poplar
Populus deltoides Marsh.	plains cottonwood
Populus tremuloides Michx.	aspen
porcupine grass	**Stipa spartea** Trin.
Potamogeton spp.	pondweeds
Potentilla fruticosa L.	shrubby cinquefoil
prairie crocus	**Anemone patens** L.
prairie sagewort	**Artemisia ludoviciana** Nutt.
prairie selaginella	**Selaginella densa** Rydb.
prickly rose	**Rosa acicularis** Lindl.

Prunus virginiana L.	choke cherry
Pseudotsuga menziesii (Mirb.) Franco	Douglas fir
Ptilium crista-castrensis (Hedw.) De Not.	knight's plume moss *(Feathermoss)*
purple peavine	**Lathyrus venosus** Muhl.
purple rattle	**Pedicularis sudetica** Willd.
pussy willow	**Salix discolor** Muhl.
red and white baneberry	**Actaea rubra** (Ait.) Willd.
red heather	**Phyllodoce empetriformis** (Smith) D. Don
red-osier dogwood	**Cornus stolonifera** Michx.
reindeer lichen	**Cladina mitis** (Sandst.) Hale & W. Culb.
Rhododendron albiflorum Hook.	white-flowered rhododendron
river alder	**Alnus tenuifolia** Nutt.
Rocky Mountain fescue	**Festuca saximontana** Rydb.
Rosa acicularis Lindl.	prickly rose
Rosa spp.	wild and prickly rose
Rosa woodsii Lindl.	common wild rose
round-leaved hawthorn	**Crataegus rotundifolia** Moench
Rubus arcticus L.	dwarf raspberry
Rubus chamaemorus L.	cloudberry
Rubus idaeus L.	wild red raspberry
Rubus parviflorus Nutt.	thimbleberry
Rubus pedatus J.E. Smith	dwarf bramble
Rubus pubescens Raf.	dewberry
Salicornia rubra Wolff & Jefferies	samphire
Salix barrattiana Hook.	Barratt's willow
Salix bebbiana Sarg.	beaked willow
Salix discolor Muhl.	pussy willow
Salix drummondiana Barr. ex Hook.	Drummond's willow
Salix exigua Nutt.	sandbar willow
Salix petiolaris J.E. Smith	basket willow
Salix planifolia Pursh	flat-leaved willow
Salix scouleriana Barr. ex Hook.	Scouler's willow
Salix spp.	willows
samphire	**Salicornia rubra** Wolff & Jefferies
sand grass	**Calamovilfa longifolia** (Hook.) Scribn.
sand heather	**Hudsonia tomentosa** Nutt.
sandbar willow	**Salix exigua** Nutt.

sand-dune chickweed	**Stellaria arenicola** Raup
saskatoon	**Amelanchier alnifolia** Nutt.
Schreber's moss *(Feathermoss)*	**Pleurozium schreberi** (Brid.) Mitt.
Scirpus spp.	bulrushes
Scolochloa festucacea (Willd.) Link	spangletop
Scouler's willow	**Salix scouleriana** Barr. ex Hook.
sedges	Carex spp.
Selaginella densa Rydb.	prairie selaginella
sheathed cotton grass	**Eriophorum vaginatum** L.
Shepherdia argentea Nutt.	Thorny buffaloberry
Shepherdia canadensis (L.) Nutt.	Canada buffaloberry
shrubby cinquefoil	**Potentilla fruticosa** L.
silver sagebrush	**Artemisia cana** Pursh
silverberry	**Elaeagnus commutata** Bernh. ex Rydb.
silvery perennial lupine	**Lupinus argenteus** Pursh
slender wheat grass	**Agropyron trachycaulum** (Link) Malte
small bottle sedge	**Carex utriculata** Boott (a)
snowberry	**Symphoricarpos albus** (L.) Blake
spangletop	**Scolochloa festucacea** (Willd.) Link
Sphagnum magellanicum Brid.	midway peat moss
Sphagnum spp.	peat mosses
spike-rush	Eleocharis spp.
Spiraea betulifolia Pallas	white meadowsweet
stair-step moss *(Feathermoss)*	**Hylocomium splendens** (Hedw.) B.S.G.
Stellaria arenicola Raup	sand-dune chickweed
sticky purple geranium	**Geranium viscosissimum** Fisch. & Mey.
Stipa comata Trin. & Rupr.	needle-and-thread
Stipa curtiseta (A.S. Hitchc.) Barkworth	western porcupine grass
Stipa spartea Trin.	porcupine grass
Stipa spp.	needle grasses
subalpine fir	**Abies bifolia** A. Murr. (a)
subalpine larch	Larix lyallii Parl.
swamp horsetail	**Equisetum fluviatile** L.
Symphoricarpos albus (L.) Blake	snowberry
Symphoricarpos occidentalis Hook.	buckbrush
tall bilberry	**Vaccinium membranaceum** Dougl. ex Hook.
tamarack	**Larix laricina** (Du Roi) K. Koch

Thermopsis rhombifolia (Nutt.) Richards.	golden bean
thimbleberry	**Rubus parviflorus** Nutt.
Thorny buffaloberry	**Shepherdia argentea** Nutt.
three-flowered avens	**Geum triflorum** Pursh
Tomenthypnum nitens (Hedw.) Loeske	golden moss
tufted hair grass	**Deschampsia cespitosa** (L.) Beauv.
twinflower	**Linnaea borealis** L.
Typha latifolia L.	common cattail
Vaccinium membranaceum Dougl. ex Hook.	tall bilberry
Vaccinium myrtillus L.	low bilberry
Vaccinium scoparium Leiberg	grouseberry
Vaccinium uliginosum L.	bog bilberry
Vaccinium vitis-idaea L.	bog cranberry
Viburnum edule (Michx.) Raf.	low-bush cranberry
Vicia americana Muhl.	wild vetch
water sedge	**Carex aquatilis** Wahlenb.
western mountain-heather	**Cassiope mertensiana** (Bong.) D. Don
western porcupine grass	**Stipa curtiseta** (A.S. Hitchc.) Barkworth
western wheat grass	**Agropyron smithii** Rydb.
white birch	**Betula papyrifera** Marsh.
white meadowsweet	**Spiraea betulifolia** Pallas
white mountain avens	**Dryas octopetala** L.
white mountain-heather	**Cassiope tetragona** (L.) D. Don
white spruce	**Picea glauca** (Moench) Voss
whitebark pine	**Pinus albicaulis** Engelm.
white-flowered rhododendron	**Rhododendron albiflorum** Hook.
white-grained mountain rice grass	**Oryzopsis asperifolia** Michx.
wild and prickly rose	**Rosa** spp.
wild blue flax	**Linum lewisii** Pursh
wild lily-of-the-valley	**Maianthemum canadense** Desf.
wild red raspberry	**Rubus idaeus** L.
wild sarsaparilla	**Aralia nudicaulis** L.
wild white geranium	**Geranium richardsonii** Fisch. & Trautv..
wild vetch	**Vicia americana** Muhl.
willows	**Salix** spp.
Xerophyllum tenax (Pursh) Nutt.	bear-grass
yellow heather	**Phyllodoce glanduliflora** (Hook.) Coville

APPENDIX 2. DETAILED CLIMATE STATISTICS

Detailed climate statistics used to compile the maps and figures in this report are presented here. The variables are briefly described in Part 2 and their derivation is more completely discussed in another document (Alberta Sustainable Resource Development 2004). They are tabulated below in three groups:

- 13 temperature-related derived variables,
- 4 precipitation-related derived variables, and
- 48 primary temperature and precipitation variables on which the derived variables are based.

Tables for derived variables are presented in the order in which they are discussed in Part 2.

Derived Temperature Variables

Mean Annual Temperature °C

Natural Region	Natural Subregion	Minimum	Maximum	Range	Mean	Standard Deviation
Rocky Mountain	Alpine	-7.1	3.0	10.1	-2.4	1.0
Rocky Mountain	Subalpine	-5.1	4.0	9.1	-0.1	1.0
Rocky Mountain	Montane	-1.7	4.5	6.2	2.3	0.7
Foothills	Upper Foothills	-1.6	2.5	4.1	1.3	0.4
Foothills	Lower Foothills	0.1	2.9	2.9	1.8	0.5
Grassland	Dry Mixedgrass	1.8	6.0	4.2	4.2	1.0
Grassland	Mixedgrass	2.0	5.9	3.9	4.4	0.8
Grassland	Northern Fescue	1.6	3.9	2.4	2.7	0.5
Grassland	Foothills Fescue	2.7	5.6	3.0	3.9	0.7
Parkland	Foothills Parkland	2.0	4.6	2.5	3.0	0.4
Parkland	Central Parkland	0.9	3.6	2.7	2.3	0.5
Parkland	Peace River Parkland	0.6	2.1	1.5	1.5	0.2
Boreal Forest	Dry Mixedwood	-1.6	3.2	4.8	1.1	1.1
Boreal Forest	Central Mixedwood	-2.6	3.1	5.6	0.2	1.1
Boreal Forest	Lower Boreal Highlands	-4.0	0.9	4.9	-1.0	1.0
Boreal Forest	Upper Boreal Highlands	-2.5	-0.3	2.2	-1.5	0.4
Boreal Forest	Athabasca Plain	-2.4	-0.2	2.2	-1.2	0.4
Boreal Forest	Peace-Athabasca Delta	-2.3	-0.8	1.5	-1.4	0.3
Boreal Forest	Northern Mixedwood	-3.5	-1.8	1.8	-2.5	0.3
Boreal Forest	Boreal Subarctic	-4.7	-2.2	2.5	-3.6	0.3
Canadian Shield	Kazan Uplands	-3.7	-0.8	2.9	-2.6	0.5

Mean Temperature of the Warmest Month* °C

Natural Region	Natural Subregion	Minimum	Maximum	Range	Mean	Standard Deviation
Rocky Mountain	Alpine	3.3	14.7	11.4	8.7	1.2
Rocky Mountain	Subalpine	5.4	15.4	10.0	11.3	1.2
Rocky Mountain	Montane	10.0	16.6	6.6	13.9	0.8
Foothills	Upper Foothills	9.2	14.6	5.4	13.4	0.6
Foothills	Lower Foothills	12.6	15.8	3.2	14.7	0.4
Grassland	Dry Mixedgrass	17.0	19.8	2.8	18.5	0.5
Grassland	Mixedgrass	15.0	19.1	4.1	17.6	0.5
Grassland	Northern Fescue	16.1	18.4	2.3	17.2	0.3
Grassland	Foothills Fescue	14.0	18.1	4.1	16.3	0.6
Parkland	Foothills Parkland	13.2	16.1	2.9	14.7	0.5
Parkland	Central Parkland	14.6	17.7	3.1	16.5	0.5
Parkland	Peace River Parkland	14.9	17.4	2.5	15.9	0.5
Boreal Forest	Dry Mixedwood	14.1	17.5	3.4	15.9	0.5
Boreal Forest	Central Mixedwood	14.0	17.3	3.3	15.9	0.5
Boreal Forest	Lower Boreal Highlands	13.5	16.2	2.7	15.0	0.4
Boreal Forest	Upper Boreal Highlands	13.3	15.4	2.1	14.3	0.4
Boreal Forest	Athabasca Plain	15.3	17.5	2.2	17.0	0.5
Boreal Forest	Peace-Athabasca Delta	16.9	17.4	0.5	17.2	0.1
Boreal Forest	Northern Mixedwood	14.6	17.0	2.4	15.9	0.5
Boreal Forest	Boreal Subarctic	12.6	14.9	2.3	13.8	0.5
Canadian Shield	Kazan Uplands	15.9	17.2	1.3	16.6	0.2

Mean temperature for July or August

Mean Temperature of the Coldest Month* °C

Natural Region	Natural Subregion	Minimum	Maximum	Range	Mean	Standard Deviation
Rocky Mountain	Alpine	-14.2	-8.6	5.6	-12.6	0.7
Rocky Mountain	Subalpine	-14.0	-7.4	6.6	-11.7	1.0
Rocky Mountain	Montane	-13.9	-7.2	6.7	-10.0	1.2
Foothills	Upper Foothills	-14.5	-9.8	4.7	-11.6	0.6
Foothills	Lower Foothills	-17.6	-9.9	7.7	-12.8	1.5
Grassland	Dry Mixedgrass	-16.1	-7.9	8.2	-12.1	2.0
Grassland	Mixedgrass	-14.0	-7.4	6.6	-10.2	1.5
Grassland	Northern Fescue	-16.6	-11.9	4.7	-14.3	1.1
Grassland	Foothills Fescue	-13.7	-6.9	6.8	-9.7	1.9
Parkland	Foothills Parkland	-10.7	-7.2	3.5	-9.6	0.7
Parkland	Central Parkland	-17.9	-9.8	8.1	-14.7	1.5
Parkland	Peace River Parkland	-18.9	-14.1	4.8	-15.9	1.1
Boreal Forest	Dry Mixedwood	-22.5	-10.5	12.0	-16.8	2.7
Boreal Forest	Central Mixedwood	-24.5	-11.3	13.2	-18.7	2.8
Boreal Forest	Lower Boreal Highlands	-24.4	-16.4	8.0	-20.0	1.8
Boreal Forest	Upper Boreal Highlands	-22.0	-17.3	4.7	-19.9	1.0
Boreal Forest	Athabasca Plain	-25.2	-20.3	4.9	-22.7	1.1
Boreal Forest	Peace-Athabasca Delta	-24.7	-22.4	2.3	-23.3	0.5
Boreal Forest	Northern Mixedwood	-25.6	-22.4	3.2	-23.8	0.5
Boreal Forest	Boreal Subarctic	-24.3	-22.1	2.2	-23.1	0.5
Canadian Shield	Kazan Uplands	-26.5	-21.9	4.6	-25.1	0.8

* Minimum daily average for December or January

Mean Daily Maximum Temperature* °C

Natural Region	Natural Subregion	Minimum	Maximum	Range	Mean	Standard Deviation
Rocky Mountain	Alpine	3.3	22.2	18.9	12.9	2.1
Rocky Mountain	Subalpine	7.2	22.8	15.6	17.0	1.8
Rocky Mountain	Montane	14.9	24.0	9.1	21.2	1.0
Foothills	Upper Foothills	13.1	21.8	8.7	19.5	0.7
Foothills	Lower Foothills	17.7	22.4	4.7	20.9	0.6
Grassland	Dry Mixedgrass	24.1	28.6	4.5	26.2	0.7
Grassland	Mixedgrass	21.0	27.3	6.3	25.1	0.7
Grassland	Northern Fescue	22.4	26.1	3.7	24.3	0.5
Grassland	Foothills Fescue	21.5	26.0	4.5	23.8	0.8
Parkland	Foothills Parkland	20.8	23.6	2.8	22.1	0.5
Parkland	Central Parkland	21.4	25.4	4.0	23.0	0.6
Parkland	Peace River Parkland	21.0	25.5	4.5	22.4	0.8
Boreal Forest	Dry Mixedwood	19.6	25.6	6.0	22.4	0.6
Boreal Forest	Central Mixedwood	20.1	24.0	3.9	22.0	0.7
Boreal Forest	Lower Boreal Highlands	18.1	22.7	4.6	20.7	0.7
Boreal Forest	Upper Boreal Highlands	17.9	20.7	2.8	19.4	0.5
Boreal Forest	Athabasca Plain	20.3	23.8	3.5	22.8	0.7
Boreal Forest	Peace-Athabasca Delta	22.7	23.4	0.7	23.2	0.1
Boreal Forest	Northern Mixedwood	20.2	23.3	3.1	22.1	0.6
Boreal Forest	Boreal Subarctic	17.0	20.9	3.9	18.8	0.9
Canadian Shield	Kazan Uplands	21.1	23.1	2.0	22.3	0.4

*Mean monthly maximum daily temperatures for June, July and August

Mean Daily Minimum Temperature* °C

Natural Region	Natural Subregion	Minimum	Maximum	Range	Mean	Standard Deviation
Rocky Mountain	Alpine	-19.5	-13.4	6.1	-17.2	1.0
Rocky Mountain	Subalpine	-19.9	-12.5	7.4	-17.0	1.4
Rocky Mountain	Montane	-20.0	-12.2	7.8	-16.1	1.3
Foothills	Upper Foothills	-20.0	-14.4	5.6	-17.8	0.7
Foothills	Lower Foothills	-23.2	-16.1	7.1	-18.9	1.3
Grassland	Dry Mixedgrass	-21.9	-13.6	8.3	-17.7	2.1
Grassland	Mixedgrass	-19.4	-13.5	5.9	-15.9	1.4
Grassland	Northern Fescue	-22.0	-17.4	4.6	-19.8	1.2
Grassland	Foothills Fescue	-19.2	-12.7	6.5	-15.7	1.8
Parkland	Foothills Parkland	-17.5	-12.3	5.2	-16.0	1.1
Parkland	Central Parkland	-23.2	-15.8	7.4	-20.0	1.5
Parkland	Peace River Parkland	-24.1	-19.8	4.3	-21.4	0.9
Boreal Forest	Dry Mixedwood	-27.6	-17.3	10.3	-22.3	2.7
Boreal Forest	Central Mixedwood	-29.1	-17.0	12.1	-24.2	2.7
Boreal Forest	Lower Boreal Highlands	-29.7	-22.1	7.6	-25.5	1.7
Boreal Forest	Upper Boreal Highlands	-27.2	-22.8	4.4	-25.3	0.9
Boreal Forest	Athabasca Plain	-30.6	-25.8	4.8	-28.4	1.1
Boreal Forest	Peace-Athabasca Delta	-29.4	-27.8	1.6	-28.5	0.4
Boreal Forest	Northern Mixedwood	-29.9	-27.4	2.5	-28.9	0.5
Boreal Forest	Boreal Subarctic	-29.6	-27.0	2.6	-28.2	0.6
Canadian Shield	Kazan Uplands	-31.3	-27.8	3.5	-30.0	0.6

* Mean monthly minimum daily temperatures for December, January and February

Growing Degree Days > 5°C						
Natural Region	**Natural Subregion**	**Minimum**	**Maximum**	**Range**	**Mean**	**Standard Deviation**
Rocky Mountain	Alpine	0	1129	1129	317	161
Rocky Mountain	Subalpine	0	1221	1221	668	150
Rocky Mountain	Montane	484	1402	918	1017	112
Foothills	Upper Foothills	396	1132	736	949	81
Foothills	Lower Foothills	846	1325	479	1145	62
Grassland	Dry Mixedgrass	1434	1878	444	1690	91
Grassland	Mixedgrass	1147	1806	659	1578	91
Grassland	Northern Fescue	1333	1689	356	1490	45
Grassland	Foothills Fescue	1051	1675	624	1388	91
Parkland	Foothills Parkland	924	1344	420	1158	74
Parkland	Central Parkland	1159	1589	430	1412	60
Parkland	Peace River Parkland	1191	1536	345	1318	62
Boreal Forest	Dry Mixedwood	1073	1548	476	1301	70
Boreal Forest	Central Mixedwood	1031	1425	393	1240	49
Boreal Forest	Lower Boreal Highlands	829	1288	459	1097	74
Boreal Forest	Upper Boreal Highlands	843	1139	296	990	45
Boreal Forest	Athabasca Plain	1074	1377	303	1286	53
Boreal Forest	Peace-Athabasca Delta	1210	1348	137	1287	25
Boreal Forest	Northern Mixedwood	941	1227	286	1121	55
Boreal Forest	Boreal Subarctic	698	1058	360	869	52
Canadian Shield	Kazan Uplands	1029	1318	289	1160	51

Degree-Days <0 °C*						
Natural Region	**Natural Subregion**	**Minimum**	**Maximum**	**Range**	**Mean**	**Standard Deviation**
Rocky Mountain	Alpine	1056	2399	1343	1866	147
Rocky Mountain	Subalpine	834	2209	1374	1550	164
Rocky Mountain	Montane	773	1832	1059	1169	147
Foothills	Upper Foothills	1115	1815	700	1401	84
Foothills	Lower Foothills	1120	1957	838	1466	169
Grassland	Dry Mixedgrass	789	1765	976	1240	250
Grassland	Mixedgrass	735	1478	742	1043	188
Grassland	Northern Fescue	1283	1779	496	1535	143
Grassland	Foothills Fescue	725	1417	692	1032	199
Parkland	Foothills Parkland	768	1190	422	1080	85
Parkland	Central Parkland	1076	1954	879	1585	166
Parkland	Peace River Parkland	1580	2020	441	1757	101
Boreal Forest	Dry Mixedwood	1155	2645	1491	1872	333
Boreal Forest	Central Mixedwood	1293	2886	1593	2106	354
Boreal Forest	Lower Boreal Highlands	1862	3123	1261	2333	271
Boreal Forest	Upper Boreal Highlands	2093	2668	576	2378	127
Boreal Forest	Athabasca Plain	2302	2946	644	2614	138
Boreal Forest	Peace-Athabasca Delta	2528	2885	358	2660	69
Boreal Forest	Northern Mixedwood	2640	3058	418	2882	66
Boreal Forest	Boreal Subarctic	2686	3147	460	2953	74
Canadian Shield	Kazan Uplands	2505	3179	674	2958	120

* Sum of degree-days below 0 °C

Growing Season Degree Days* > 5°C						
Natural Region	**Natural Subregion**	**Minimum**	**Maximum**	**Range**	**Mean**	**Standard Deviation**
Rocky Mountain	Alpine	-439	832	1271	196	129
Rocky Mountain	Subalpine	-184	964	1148	457	117
Rocky Mountain	Montane	322	1049	727	708	111
Foothills	Upper Foothills	284	938	654	691	97
Foothills	Lower Foothills	528	1073	545	887	80
Grassland	Dry Mixedgrass	1008	1504	496	1318	94
Grassland	Mixedgrass	840	1437	597	1217	88
Grassland	Northern Fescue	1018	1292	274	1140	37
Grassland	Foothills Fescue	683	1318	635	1052	88
Parkland	Foothills Parkland	596	1066	470	821	91
Parkland	Central Parkland	801	1269	467	1092	65
Parkland	Peace River Parkland	965	1235	270	1073	54
Boreal Forest	Dry Mixedwood	711	1244	533	1049	72
Boreal Forest	Central Mixedwood	815	1167	352	1030	46
Boreal Forest	Lower Boreal Highlands	738	1086	348	933	55
Boreal Forest	Upper Boreal Highlands	731	980	249	852	48
Boreal Forest	Athabasca Plain	940	1173	233	1107	44
Boreal Forest	Peace-Athabasca Delta	1052	1173	121	1113	21
Boreal Forest	Northern Mixedwood	860	1092	232	986	47
Boreal Forest	Boreal Subarctic	644	922	277	784	50
Canadian Shield	Kazan Uplands	914	1126	213	1014	39

*Statistics represent sum of degree-days > 5°C from April through August

First day* when Growing Degree Days >5 sum to 100						
Natural Region	**Natural Subregion**	**Minimum**	**Maximum**	**Range**	**Mean**	**Standard Deviation**
Rocky Mountain	Alpine	143	230	87	186	9
Rocky Mountain	Subalpine	140	212	72	165	9
Rocky Mountain	Montane	135	179	44	148	5
Foothills	Upper Foothills	139	179	41	148	4
Foothills	Lower Foothills	132	154	22	139	3
Grassland	Dry Mixedgrass	120	136	16	126	3
Grassland	Mixedgrass	122	145	23	129	3
Grassland	Northern Fescue	124	136	12	131	1
Grassland	Foothills Fescue	125	147	22	134	3
Parkland	Foothills Parkland	134	151	17	141	3
Parkland	Central Parkland	126	141	15	131	2
Parkland	Peace River Parkland	126	138	11	133	2
Boreal Forest	Dry Mixedwood	126	143	17	134	3
Boreal Forest	Central Mixedwood	130	149	19	138	3
Boreal Forest	Lower Boreal Highlands	135	158	23	143	4
Boreal Forest	Upper Boreal Highlands	141	154	13	148	2
Boreal Forest	Athabasca Plain	134	147	12	140	2
Boreal Forest	Peace-Athabasca Delta	138	145	8	141	1
Boreal Forest	Northern Mixedwood	141	153	12	147	3
Boreal Forest	Boreal Subarctic	147	163	16	155	2
Canadian Shield	Kazan Uplands	138	154	16	147	3

*Statistics represent number of days from January 1

Frost Free Period (days)

Natural Region	Natural Subregion	Minimum	Maximum	Range	Mean	Standard Deviation
Rocky Mountain	Alpine	13	88	75	40	10
Rocky Mountain	Subalpine	13	97	84	55	16
Rocky Mountain	Montane	16	101	85	64	15
Foothills	Upper Foothills	33	116	82	79	17
Foothills	Lower Foothills	40	118	78	94	12
Grassland	Dry Mixedgrass	87	130	43	113	10
Grassland	Mixedgrass	86	125	39	110	7
Grassland	Northern Fescue	89	119	30	103	5
Grassland	Foothills Fescue	54	116	62	97	8
Parkland	Foothills Parkland	44	102	58	76	13
Parkland	Central Parkland	76	123	47	102	7
Parkland	Peace River Parkland	86	114	28	102	5
Boreal Forest	Dry Mixedwood	66	124	58	98	9
Boreal Forest	Central Mixedwood	74	116	43	97	7
Boreal Forest	Lower Boreal Highlands	81	118	37	97	7
Boreal Forest	Upper Boreal Highlands	88	111	23	97	6
Boreal Forest	Athabasca Plain	92	108	16	103	2
Boreal Forest	Peace-Athabasca Delta	96	108	13	102	3
Boreal Forest	Northern Mixedwood	76	100	24	89	4
Boreal Forest	Boreal Subarctic	83	92	9	88	2
Canadian Shield	Kazan Uplands	94	104	11	99	2

Last Spring Frost Day (days from January 1)

Natural Region	Natural Subregion	Minimum	Maximum	Range	Mean	Standard Deviation
Rocky Mountain	Alpine	165	214	49	195	6
Rocky Mountain	Subalpine	158	207	49	182	8
Rocky Mountain	Montane	151	197	45	173	8
Foothills	Upper Foothills	146	189	43	166	9
Foothills	Lower Foothills	145	185	39	156	6
Grassland	Dry Mixedgrass	134	156	22	143	4
Grassland	Mixedgrass	138	159	21	146	4
Grassland	Northern Fescue	141	155	14	148	2
Grassland	Foothills Fescue	144	178	35	154	4
Parkland	Foothills Parkland	153	183	30	166	7
Parkland	Central Parkland	138	164	26	149	4
Parkland	Peace River Parkland	144	158	14	149	3
Boreal Forest	Dry Mixedwood	140	170	30	151	4
Boreal Forest	Central Mixedwood	144	165	21	152	3
Boreal Forest	Lower Boreal Highlands	142	162	20	152	4
Boreal Forest	Upper Boreal Highlands	146	159	12	154	3
Boreal Forest	Athabasca Plain	146	153	7	149	1
Boreal Forest	Peace-Athabasca Delta	146	153	7	149	2
Boreal Forest	Northern Mixedwood	151	162	11	157	2
Boreal Forest	Boreal Subarctic	155	163	8	160	1
Canadian Shield	Kazan Uplands	147	155	8	151	2

First Fall Frost (days from January 1)

Natural Region	Natural Subregion	Minimum	Maximum	Range	Mean	Standard Deviation
Rocky Mountain	Alpine	221	249	28	231	3
Rocky Mountain	Subalpine	219	252	33	235	6
Rocky Mountain	Montane	221	253	32	238	6
Foothills	Upper Foothills	227	256	29	242	6
Foothills	Lower Foothills	227	256	30	247	5
Grassland	Dry Mixedgrass	242	263	21	255	5
Grassland	Mixedgrass	244	262	18	255	3
Grassland	Northern Fescue	244	257	14	250	2
Grassland	Foothills Fescue	233	258	25	250	3
Parkland	Foothills Parkland	230	254	25	242	5
Parkland	Central Parkland	240	259	19	250	3
Parkland	Peace River Parkland	243	254	11	249	2
Boreal Forest	Dry Mixedwood	237	260	22	247	4
Boreal Forest	Central Mixedwood	238	256	18	247	3
Boreal Forest	Lower Boreal Highlands	237	253	16	246	3
Boreal Forest	Upper Boreal Highlands	242	251	9	246	2
Boreal Forest	Athabasca Plain	245	252	6	250	1
Boreal Forest	Peace-Athabasca Delta	247	252	5	249	1
Boreal Forest	Northern Mixedwood	235	249	13	243	3
Boreal Forest	Boreal Subarctic	238	245	6	242	2
Canadian Shield	Kazan Uplands	247	250	3	248	0

Continentality Index

Natural Region	Natural Subregion	Minimum	Maximum	Range	Mean	Standard Deviation
Rocky Mountain	Alpine	15.9	25.7	9.8	21.2	1.2
Rocky Mountain	Subalpine	17.5	26.6	9.1	23.0	1.2
Rocky Mountain	Montane	21.9	28.6	6.7	23.9	1.1
Foothills	Upper Foothills	20.2	29.1	8.9	25.0	0.9
Foothills	Lower Foothills	23.6	33.1	9.5	27.5	1.7
Grassland	Dry Mixedgrass	26.2	33.7	7.5	30.6	1.7
Grassland	Mixedgrass	23.9	32	8.1	27.8	1.4
Grassland	Northern Fescue	28.7	34.4	5.7	31.5	1.2
Grassland	Foothills Fescue	22.9	30.8	7.9	26.0	2.0
Parkland	Foothills Parkland	22.5	25.9	3.4	24.3	0.7
Parkland	Central Parkland	24.7	34.9	10.2	31.2	1.8
Parkland	Peace River Parkland	29	36.3	7.3	31.8	1.5
Boreal Forest	Dry Mixedwood	24.8	39.2	14.4	32.7	2.9
Boreal Forest	Central Mixedwood	26.5	41.4	14.9	34.6	3.2
Boreal Forest	Lower Boreal Highlands	31.2	39.9	8.7	35.0	1.8
Boreal Forest	Upper Boreal Highlands	30.9	37.1	6.2	34.2	1.3
Boreal Forest	Athabasca Plain	36.3	42.2	5.9	39.7	1.4
Boreal Forest	Peace-Athabasca Delta	39.7	41.6	1.9	40.5	0.4
Boreal Forest	Northern Mixedwood	37.5	42	4.5	39.7	0.9
Boreal Forest	Boreal Subarctic	35.1	39	3.9	36.8	0.9
Canadian Shield	Kazan Uplands	38.6	42.6	4	41.7	0.6

Derived Precipitation Variables

Mean Annual Precipitation (mm)						
Natural Region	**Natural Subregion**	**Minimum**	**Maximum**	**Range**	**Mean**	**Standard Deviation**
Rocky Mountain	Alpine	496.4	1708.7	1212.3	989.4	157.5
Rocky Mountain	Subalpine	440.3	1474.4	1034.1	755.5	144.6
Rocky Mountain	Montane	415.1	1341.5	926.4	588.6	96.2
Foothills	Upper Foothills	452.5	992.9	540.4	632.4	40.0
Foothills	Lower Foothills	472.9	742.5	269.6	588.4	33.2
Grassland	Dry Mixedgrass	259.9	412.3	152.4	333.3	23.2
Grassland	Mixedgrass	288.5	542.5	254.0	394.1	36.1
Grassland	Northern Fescue	316.6	441.6	125.0	384.6	21.6
Grassland	Foothills Fescue	357.8	810.7	452.9	469.6	76.5
Parkland	Foothills Parkland	391.1	1020.6	629.5	517.0	99.7
Parkland	Central Parkland	356.9	526.8	169.9	441.2	29.5
Parkland	Peace River Parkland	361.1	521.9	160.8	450.2	35.7
Boreal Forest	Dry Mixedwood	359.7	583.8	224.1	460.6	43.0
Boreal Forest	Central Mixedwood	333.6	634.7	301.1	477.5	56.4
Boreal Forest	Lower Boreal Highlands	393.9	620.2	226.3	495.2	38.1
Boreal Forest	Upper Boreal Highlands	460.0	602.5	142.5	534.5	19.5
Boreal Forest	Athabasca Plain	368.6	554.5	185.9	428.3	42.8
Boreal Forest	Peace-Athabasca Delta	342.5	418.6	76.1	376.8	14.6
Boreal Forest	Northern Mixedwood	304.7	494.1	189.4	386.8	36.9
Boreal Forest	Boreal Subarctic	440.8	585.8	145.0	512.3	30.2
Canadian Shield	Kazan Uplands	337.5	473.7	136.2	380.1	16.3

Growing Season* Precipitation (mm)						
Natural Region	**Natural Subregion**	**Minimum**	**Maximum**	**Range**	**Mean**	**Standard Deviation**
Rocky Mountain	Alpine	270.2	726.4	456.2	471.5	48.4
Rocky Mountain	Subalpine	254.9	623.5	368.6	419.4	49.4
Rocky Mountain	Montane	248.6	597.2	348.6	382.4	47.1
Foothills	Upper Foothills	306.0	535.1	229.1	450.4	29.2
Foothills	Lower Foothills	309.3	516.2	206.9	429.7	33.0
Grassland	Dry Mixedgrass	200.3	286.4	86.1	241.1	13.5
Grassland	Mixedgrass	224.9	361.4	136.5	281.7	19.9
Grassland	Northern Fescue	243.2	328.8	85.6	286.8	15.3
Grassland	Foothills Fescue	278.3	460.8	182.5	333.1	29.5
Parkland	Foothills Parkland	310.9	527.0	216.1	377.4	31.9
Parkland	Central Parkland	273.1	395.5	122.4	330.1	23.6
Parkland	Peace River Parkland	239.5	349.3	109.8	299.6	23.5
Boreal Forest	Dry Mixedwood	236.8	440.8	204.0	324.2	43.7
Boreal Forest	Central Mixedwood	224.7	453.0	228.3	336.2	46.8
Boreal Forest	Lower Boreal Highlands	242.2	437.8	195.6	334.4	32.7
Boreal Forest	Upper Boreal Highlands	301.2	414.1	112.9	357.7	16.3
Boreal Forest	Athabasca Plain	234.7	368.6	133.9	286.9	32.2
Boreal Forest	Peace-Athabasca Delta	227.1	291.7	64.6	257.1	11.0
Boreal Forest	Northern Mixedwood	204.4	315.7	111.3	247.0	23.5
Boreal Forest	Boreal Subarctic	271.9	368.7	96.8	316.9	21.2
Canadian Shield	Kazan Uplands	218.6	320.0	101.4	241.9	12.5

* Statistics represent total precipitation (mm) from April to August

Summer Moisture Index*						
Natural Region	**Natural Subregion**	**Minimum**	**Maximum**	**Range**	**Mean**	**Standard Deviation**
Rocky Mountain	Alpine	0.0	3.3	3.3	0.7	0.4
Rocky Mountain	Subalpine	0.0	3.7	3.7	1.6	0.4
Rocky Mountain	Montane	1.0	4.9	3.9	2.7	0.5
Foothills	Upper Foothills	0.8	3.1	2.3	2.1	0.2
Foothills	Lower Foothills	1.8	4.0	2.2	2.7	0.3
Grassland	Dry Mixedgrass	5.2	9.3	4.1	7.0	0.6
Grassland	Mixedgrass	3.2	7.6	4.5	5.6	0.6
Grassland	Northern Fescue	4.1	6.6	2.6	5.2	0.4
Grassland	Foothills Fescue	2.6	5.6	3.0	4.2	0.5
Parkland	Foothills Parkland	2.1	4.3	2.2	3.1	0.4
Parkland	Central Parkland	3.0	5.8	2.8	4.3	0.4
Parkland	Peace River Parkland	3.5	6.4	2.8	4.4	0.6
Boreal Forest	Dry Mixedwood	2.5	6.4	4.0	4.1	0.6
Boreal Forest	Central Mixedwood	2.5	5.3	2.8	3.8	0.6
Boreal Forest	Lower Boreal Highlands	2.3	4.5	2.2	3.3	0.3
Boreal Forest	Upper Boreal Highlands	2.2	3.5	1.3	2.8	0.2
Boreal Forest	Athabasca Plain	2.9	5.3	2.4	4.5	0.6
Boreal Forest	Peace-Athabasca Delta	4.6	5.3	0.8	5.0	0.1
Boreal Forest	Northern Mixedwood	3.0	5.6	2.6	4.6	0.6
Boreal Forest	Boreal Subarctic	2.0	3.7	1.6	2.8	0.3
Canadian Shield	Kazan Uplands	3.9	5.4	1.5	4.8	0.2

*April through August

Annual Moisture Index						
Natural Region	**Natural Subregion**	**Minimum**	**Maximum**	**Range**	**Mean**	**Standard Deviation**
Rocky Mountain	Alpine	0.0	2.2	2.2	0.4	0.2
Rocky Mountain	Subalpine	0.0	2.4	2.4	0.9	0.3
Rocky Mountain	Montane	0.5	3.3	2.8	1.8	0.3
Foothills	Upper Foothills	0.4	2.2	1.8	1.5	0.2
Foothills	Lower Foothills	1.2	2.7	1.5	2.0	0.2
Grassland	Dry Mixedgrass	3.8	7.2	3.4	5.1	0.5
Grassland	Mixedgrass	2.2	5.9	3.7	4.0	0.5
Grassland	Northern Fescue	3.0	5.0	2.0	3.9	0.3
Grassland	Foothills Fescue	1.6	4.3	2.7	3.0	0.5
Parkland	Foothills Parkland	1.1	3.4	2.4	2.3	0.4
Parkland	Central Parkland	2.4	4.5	2.1	3.2	0.3
Parkland	Peace River Parkland	2.4	4.2	1.9	3.0	0.4
Boreal Forest	Dry Mixedwood	1.9	4.2	2.3	2.8	0.3
Boreal Forest	Central Mixedwood	1.8	3.6	1.9	2.6	0.3
Boreal Forest	Lower Boreal Highlands	1.5	2.9	1.4	2.2	0.2
Boreal Forest	Upper Boreal Highlands	1.5	2.3	0.9	1.9	0.1
Boreal Forest	Athabasca Plain	1.9	3.4	1.5	3.0	0.4
Boreal Forest	Peace-Athabasca Delta	3.2	3.6	0.5	3.4	0.1
Boreal Forest	Northern Mixedwood	1.9	3.8	1.8	2.9	0.4
Boreal Forest	Boreal Subarctic	1.2	2.3	1.1	1.7	0.2
Canadian Shield	Kazan Uplands	2.6	3.5	0.9	3.1	0.2

Primary Temperature Variables

Mean Minimum Temperature °C, January

Natural Region	Natural Subregion	Minimum	Maximum	Range	Mean	Standard Deviation
Rocky Mountain	Alpine	-19.5	-13.4	6.1	-17.2	1.0
Rocky Mountain	Subalpine	-19.9	-12.5	7.4	-17.0	1.4
Rocky Mountain	Montane	-20.0	-12.2	7.8	-16.1	1.3
Foothills	Upper Foothills	-20.0	-14.4	5.6	-17.8	0.7
Foothills	Lower Foothills	-23.2	-16.1	7.1	-18.9	1.3
Grassland	Dry Mixedgrass	-21.9	-13.6	8.3	-17.7	2.1
Grassland	Mixedgrass	-19.4	-13.5	5.9	-15.9	1.4
Grassland	Northern Fescue	-22.0	-17.4	4.6	-19.8	1.2
Grassland	Foothills Fescue	-19.2	-12.7	6.5	-15.7	1.8
Parkland	Foothills Parkland	-17.5	-12.3	5.2	-16.0	1.1
Parkland	Central Parkland	-23.2	-15.8	7.4	-20.0	1.5
Parkland	Peace River Parkland	-24.1	-19.8	4.3	-21.4	0.9
Boreal Forest	Dry Mixedwood	-27.6	-17.3	10.3	-22.3	2.7
Boreal Forest	Central Mixedwood	-29.1	-17.0	12.1	-24.2	2.7
Boreal Forest	Lower Boreal Highlands	-29.7	-22.1	7.6	-25.5	1.7
Boreal Forest	Upper Boreal Highlands	-27.2	-22.8	4.4	-25.3	0.9
Boreal Forest	Athabasca Plain	-30.6	-25.8	4.8	-28.4	1.1
Boreal Forest	Peace-Athabasca Delta	-29.4	-27.8	1.6	-28.5	0.4
Boreal Forest	Northern Mixedwood	-29.9	-27.4	2.5	-28.9	0.5
Boreal Forest	Boreal Subarctic	-29.6	-27.0	2.6	-28.2	0.6
Canadian Shield	Kazan Uplands	-31.3	-27.8	3.5	-30.0	0.6

Mean Minimum Temperature °C, February

Natural Region	Natural Subregion	Minimum	Maximum	Range	Mean	Standard Deviation
Rocky Mountain	Alpine	-16.5	-11.0	5.5	-15.3	0.8
Rocky Mountain	Subalpine	-16.6	-9.8	6.8	-14.7	1.2
Rocky Mountain	Montane	-16.1	-9.5	6.6	-13.3	1.2
Foothills	Upper Foothills	-17.3	-12.3	5.0	-15.5	0.6
Foothills	Lower Foothills	-20.0	-13.6	6.4	-16.2	1.1
Grassland	Dry Mixedgrass	-18.3	-10.6	7.7	-14.2	2.0
Grassland	Mixedgrass	-15.8	-10.1	5.7	-12.5	1.4
Grassland	Northern Fescue	-18.3	-14.1	4.2	-16.2	1.3
Grassland	Foothills Fescue	-15.0	-9.7	5.3	-12.3	1.6
Parkland	Foothills Parkland	-14.1	-9.5	4.6	-13.0	1.0
Parkland	Central Parkland	-19.7	-12.7	7.0	-16.5	1.3
Parkland	Peace River Parkland	-20.0	-16.6	3.4	-17.8	0.8
Boreal Forest	Dry Mixedwood	-24.9	-13.8	11.1	-18.9	2.6
Boreal Forest	Central Mixedwood	-26.1	-14.7	11.4	-20.8	2.5
Boreal Forest	Lower Boreal Highlands	-27.3	-18.6	8.7	-21.9	1.8
Boreal Forest	Upper Boreal Highlands	-23.9	-19.7	4.2	-22.0	0.9
Boreal Forest	Athabasca Plain	-26.8	-22.3	4.5	-24.7	1.0
Boreal Forest	Peace-Athabasca Delta	-25.7	-24.1	1.6	-24.8	0.4
Boreal Forest	Northern Mixedwood	-27.3	-23.5	3.8	-25.8	0.7
Boreal Forest	Boreal Subarctic	-27.3	-23.8	3.5	-25.3	0.7
Canadian Shield	Kazan Uplands	-27.8	-24.0	3.8	-26.4	0.7

Mean Minimum Temperature °C, March

Natural Region	Natural Subregion	Minimum	Maximum	Range	Mean	Standard Deviation
Rocky Mountain	Alpine	-17.2	-8.1	9.1	-13.7	1.1
Rocky Mountain	Subalpine	-16.0	-7.2	8.8	-11.8	1.2
Rocky Mountain	Montane	-13.2	-6.8	6.4	-9.7	1.0
Foothills	Upper Foothills	-13.8	-8.9	4.9	-11.3	0.6
Foothills	Lower Foothills	-13.9	-9.2	4.7	-11.1	0.8
Grassland	Dry Mixedgrass	-12.1	-6.6	5.5	-8.7	1.4
Grassland	Mixedgrass	-10.4	-6.6	3.8	-8.1	1.0
Grassland	Northern Fescue	-12.3	-9.2	3.1	-10.6	0.9
Grassland	Foothills Fescue	-10.1	-6.5	3.6	-8.3	1.0
Parkland	Foothills Parkland	-10.4	-6.8	3.6	-9.3	0.7
Parkland	Central Parkland	-13.0	-8.7	4.3	-10.9	0.9
Parkland	Peace River Parkland	-13.7	-10.9	2.8	-12.1	0.5
Boreal Forest	Dry Mixedwood	-17.8	-9.4	8.4	-12.9	2.0
Boreal Forest	Central Mixedwood	-19.4	-9.6	9.8	-14.6	2.3
Boreal Forest	Lower Boreal Highlands	-21.7	-12.6	9.1	-16.0	1.8
Boreal Forest	Upper Boreal Highlands	-18.5	-14.4	4.1	-16.5	0.9
Boreal Forest	Athabasca Plain	-20.1	-16.1	4.0	-18.3	0.8
Boreal Forest	Peace-Athabasca Delta	-19.2	-17.6	1.6	-18.3	0.4
Boreal Forest	Northern Mixedwood	-21.1	-17.8	3.3	-19.7	0.6
Boreal Forest	Boreal Subarctic	-21.9	-18.1	3.8	-20.2	0.6
Canadian Shield	Kazan Uplands	-21.6	-17.6	4.0	-20.0	0.7

Mean Minimum Temperature °C, April

Natural Region	Natural Subregion	Minimum	Maximum	Range	Mean	Standard Deviation
Rocky Mountain	Alpine	-12.4	-3.3	9.1	-8.4	1.0
Rocky Mountain	Subalpine	-10.9	-2.5	8.4	-6.3	1.0
Rocky Mountain	Montane	-7.8	-2.0	5.8	-4.3	0.8
Foothills	Upper Foothills	-8.1	-3.2	4.9	-4.9	0.7
Foothills	Lower Foothills	-5.9	-2.4	3.5	-3.7	0.5
Grassland	Dry Mixedgrass	-3.5	-0.4	3.1	-1.7	0.7
Grassland	Mixedgrass	-4.1	-0.8	3.3	-1.9	0.6
Grassland	Northern Fescue	-3.4	-1.9	1.5	-2.7	0.3
Grassland	Foothills Fescue	-4.2	-1.2	3.0	-2.5	0.5
Parkland	Foothills Parkland	-4.9	-2.0	2.9	-3.6	0.5
Parkland	Central Parkland	-3.8	-1.1	2.7	-2.4	0.4
Parkland	Peace River Parkland	-3.7	-2.1	1.6	-2.9	0.2
Boreal Forest	Dry Mixedwood	-5.6	-1.7	3.9	-3.3	0.8
Boreal Forest	Central Mixedwood	-7.5	-2.0	5.5	-4.3	0.9
Boreal Forest	Lower Boreal Highlands	-9.0	-3.3	5.7	-5.2	1.1
Boreal Forest	Upper Boreal Highlands	-6.6	-4.5	2.1	-5.7	0.4
Boreal Forest	Athabasca Plain	-7.2	-4.7	2.5	-5.8	0.5
Boreal Forest	Peace-Athabasca Delta	-6.5	-5.2	1.3	-5.7	0.3
Boreal Forest	Northern Mixedwood	-8.4	-5.9	2.5	-7.2	0.6
Boreal Forest	Boreal Subarctic	-9.6	-6.3	3.3	-8.1	0.5
Canadian Shield	Kazan Uplands	-8.5	-5.4	3.1	-7.1	0.6

Mean Minimum Temperature °C, May

Natural Region	Natural Subregion	Minimum	Maximum	Range	Mean	Standard Deviation
Rocky Mountain	Alpine	-4.9	1.3	6.2	-2.1	0.7
Rocky Mountain	Subalpine	-3.6	2.1	5.7	-0.6	0.8
Rocky Mountain	Montane	-1.9	2.6	4.5	0.6	0.7
Foothills	Upper Foothills	-1.6	3.1	4.7	1.2	0.9
Foothills	Lower Foothills	-0.5	3.6	4.1	2.3	0.7
Grassland	Dry Mixedgrass	2.3	5.3	3.0	4.1	0.6
Grassland	Mixedgrass	1.7	4.6	2.9	3.6	0.5
Grassland	Northern Fescue	2.7	4.2	1.5	3.4	0.3
Grassland	Foothills Fescue	0.5	4.0	3.5	2.7	0.5
Parkland	Foothills Parkland	-0.1	2.8	2.9	1.4	0.6
Parkland	Central Parkland	1.5	4.8	3.3	3.7	0.5
Parkland	Peace River Parkland	2.6	3.7	1.1	3.3	0.2
Boreal Forest	Dry Mixedwood	1.0	4.7	3.7	3.1	0.5
Boreal Forest	Central Mixedwood	1.4	3.8	2.4	2.9	0.4
Boreal Forest	Lower Boreal Highlands	0.9	3.5	2.6	2.5	0.5
Boreal Forest	Upper Boreal Highlands	1.6	3.3	1.7	2.3	0.4
Boreal Forest	Athabasca Plain	2.1	3.6	1.5	3.1	0.3
Boreal Forest	Peace-Athabasca Delta	2.3	3.3	1.0	2.7	0.2
Boreal Forest	Northern Mixedwood	1.2	2.4	1.2	1.8	0.3
Boreal Forest	Boreal Subarctic	0.8	2.2	1.4	1.4	0.2
Canadian Shield	Kazan Uplands	1.3	3.5	2.2	2.1	0.3

Mean Minimum Temperature °C, June

Natural Region	Natural Subregion	Minimum	Maximum	Range	Mean	Standard Deviation
Rocky Mountain	Alpine	-1.6	5.2	6.8	1.5	0.7
Rocky Mountain	Subalpine	-0.3	5.9	6.2	3.1	0.9
Rocky Mountain	Montane	2.0	7.4	5.4	4.4	0.8
Foothills	Upper Foothills	2.1	7.5	5.4	5.0	1.0
Foothills	Lower Foothills	3.1	7.8	4.7	6.3	0.8
Grassland	Dry Mixedgrass	7.0	10.0	3.0	8.7	0.6
Grassland	Mixedgrass	6.2	9.2	3.0	8.0	0.5
Grassland	Northern Fescue	7.1	8.7	1.6	8.0	0.3
Grassland	Foothills Fescue	4.1	8.2	4.1	6.8	0.6
Parkland	Foothills Parkland	3.5	7.0	3.5	5.4	0.7
Parkland	Central Parkland	5.7	9.3	3.6	8.0	0.5
Parkland	Peace River Parkland	6.5	7.9	1.4	7.4	0.3
Boreal Forest	Dry Mixedwood	4.8	9.1	4.3	7.4	0.6
Boreal Forest	Central Mixedwood	5.5	9.2	3.7	7.5	0.5
Boreal Forest	Lower Boreal Highlands	6.0	8.4	2.4	7.1	0.4
Boreal Forest	Upper Boreal Highlands	6.1	8.0	1.9	6.9	0.4
Boreal Forest	Athabasca Plain	7.8	9.0	1.2	8.6	0.3
Boreal Forest	Peace-Athabasca Delta	8.4	9.4	1.0	8.9	0.2
Boreal Forest	Northern Mixedwood	6.2	8.6	2.4	7.3	0.5
Boreal Forest	Boreal Subarctic	5.7	7.2	1.5	6.4	0.2
Canadian Shield	Kazan Uplands	7.5	9.4	1.9	8.0	0.4

Mean Minimum Temperature °C, July

Natural Region	Natural Subregion	Minimum	Maximum	Range	Mean	Standard Deviation
Rocky Mountain	Alpine	2.4	7.4	5.0	4.3	0.6
Rocky Mountain	Subalpine	3.2	8.1	4.9	5.6	0.8
Rocky Mountain	Montane	3.9	9.7	5.8	6.5	0.9
Foothills	Upper Foothills	4.7	9.9	5.2	7.3	1.0
Foothills	Lower Foothills	5.1	10.1	5.0	8.5	0.8
Grassland	Dry Mixedgrass	9.2	12.0	2.8	10.8	0.5
Grassland	Mixedgrass	8.3	11.0	2.7	10.0	0.5
Grassland	Northern Fescue	9.2	10.8	1.6	10.1	0.3
Grassland	Foothills Fescue	5.8	10.2	4.4	8.8	0.6
Parkland	Foothills Parkland	5.3	9.1	3.8	7.4	0.8
Parkland	Central Parkland	7.5	11.4	3.9	10.0	0.6
Parkland	Peace River Parkland	8.3	9.9	1.6	9.3	0.3
Boreal Forest	Dry Mixedwood	6.8	11.3	4.5	9.5	0.7
Boreal Forest	Central Mixedwood	7.3	11.4	4.1	9.7	0.6
Boreal Forest	Lower Boreal Highlands	7.9	11.0	3.1	9.4	0.5
Boreal Forest	Upper Boreal Highlands	8.3	10.4	2.1	9.3	0.4
Boreal Forest	Athabasca Plain	10.2	11.4	1.2	11.1	0.3
Boreal Forest	Peace-Athabasca Delta	10.7	11.4	0.7	11.1	0.1
Boreal Forest	Northern Mixedwood	8.7	10.9	2.2	9.6	0.6
Boreal Forest	Boreal Subarctic	8.0	9.4	1.4	8.7	0.2
Canadian Shield	Kazan Uplands	10.1	11.2	1.1	10.8	0.2

Mean Minimum Temperature °C, August

Natural Region	Natural Subregion	Minimum	Maximum	Range	Mean	Standard Deviation
Rocky Mountain	Alpine	3.4	7.4	4.0	4.5	0.5
Rocky Mountain	Subalpine	3.5	7.6	4.1	5.3	0.8
Rocky Mountain	Montane	3.5	8.3	4.8	6.0	0.9
Foothills	Upper Foothills	4.4	8.9	4.5	6.6	0.8
Foothills	Lower Foothills	4.7	9.0	4.3	7.6	0.7
Grassland	Dry Mixedgrass	8.2	11.1	2.9	9.9	0.6
Grassland	Mixedgrass	7.8	10.4	2.6	9.3	0.5
Grassland	Northern Fescue	8.2	9.6	1.4	9.0	0.3
Grassland	Foothills Fescue	5.3	9.6	4.3	8.2	0.6
Parkland	Foothills Parkland	4.9	8.2	3.3	6.7	0.7
Parkland	Central Parkland	6.7	10.3	3.6	8.8	0.5
Parkland	Peace River Parkland	7.1	8.6	1.5	8.0	0.3
Boreal Forest	Dry Mixedwood	6.2	10.3	4.1	8.1	0.6
Boreal Forest	Central Mixedwood	6.3	9.3	3.0	8.1	0.5
Boreal Forest	Lower Boreal Highlands	6.4	9.4	3.0	7.8	0.5
Boreal Forest	Upper Boreal Highlands	7.0	8.7	1.7	7.8	0.3
Boreal Forest	Athabasca Plain	8.2	9.3	1.1	9.1	0.2
Boreal Forest	Peace-Athabasca Delta	8.1	9.3	1.2	8.7	0.3
Boreal Forest	Northern Mixedwood	6.5	8.5	2.0	7.5	0.5
Boreal Forest	Boreal Subarctic	6.4	7.8	1.4	7.1	0.2
Canadian Shield	Kazan Uplands	8.4	9.1	0.7	8.7	0.2

Mean Minimum Temperature °C, September						
Natural Region	**Natural Subregion**	**Minimum**	**Maximum**	**Range**	**Mean**	**Standard Deviation**
Rocky Mountain	Alpine	-0.4	3.3	3.7	0.7	0.4
Rocky Mountain	Subalpine	-0.5	3.7	4.2	1.4	0.8
Rocky Mountain	Montane	-0.2	3.8	4.0	1.9	0.8
Foothills	Upper Foothills	0.4	4.2	3.8	2.4	0.9
Foothills	Lower Foothills	0.4	4.3	3.9	3.1	0.6
Grassland	Dry Mixedgrass	2.6	5.5	2.9	4.4	0.7
Grassland	Mixedgrass	2.7	5.3	2.6	4.3	0.5
Grassland	Northern Fescue	2.7	4.6	1.9	3.7	0.3
Grassland	Foothills Fescue	1.4	4.6	3.2	3.5	0.5
Parkland	Foothills Parkland	0.8	4.0	3.2	2.4	0.7
Parkland	Central Parkland	2.2	5.0	2.8	3.7	0.4
Parkland	Peace River Parkland	2.7	4.0	1.3	3.5	0.2
Boreal Forest	Dry Mixedwood	1.8	5.1	3.3	3.2	0.6
Boreal Forest	Central Mixedwood	1.6	4.3	2.7	3.1	0.5
Boreal Forest	Lower Boreal Highlands	1.4	3.9	2.5	2.9	0.5
Boreal Forest	Upper Boreal Highlands	2.2	3.6	1.4	2.9	0.3
Boreal Forest	Athabasca Plain	3.0	3.9	0.9	3.6	0.1
Boreal Forest	Peace-Athabasca Delta	3.2	3.9	0.7	3.5	0.1
Boreal Forest	Northern Mixedwood	1.2	3.4	2.2	2.4	0.6
Boreal Forest	Boreal Subarctic	1.5	2.7	1.2	2.2	0.3
Canadian Shield	Kazan Uplands	3.1	3.6	0.5	3.3	0.1

Mean Minimum Temperature °C, October						
Natural Region	**Natural Subregion**	**Minimum**	**Maximum**	**Range**	**Mean**	**Standard Deviation**
Rocky Mountain	Alpine	-6.0	-0.8	5.2	-4.6	0.7
Rocky Mountain	Subalpine	-5.6	0.3	5.9	-3.5	0.9
Rocky Mountain	Montane	-4.7	0.6	5.3	-2.4	1.0
Foothills	Upper Foothills	-4.8	-0.2	4.6	-2.7	1.0
Foothills	Lower Foothills	-4.6	-0.1	4.5	-1.9	0.7
Grassland	Dry Mixedgrass	-3.9	0.7	4.6	-0.9	0.9
Grassland	Mixedgrass	-3.3	0.7	4.0	-0.6	0.8
Grassland	Northern Fescue	-3.0	-0.5	2.5	-1.8	0.5
Grassland	Foothills Fescue	-2.5	0.7	3.2	-0.9	0.9
Parkland	Foothills Parkland	-3.2	0.7	3.9	-2.0	0.9
Parkland	Central Parkland	-2.7	0.0	2.7	-1.6	0.5
Parkland	Peace River Parkland	-2.5	-0.8	1.7	-1.6	0.3
Boreal Forest	Dry Mixedwood	-4.1	0.1	4.2	-2.0	0.8
Boreal Forest	Central Mixedwood	-4.5	-0.2	4.3	-2.0	0.7
Boreal Forest	Lower Boreal Highlands	-4.9	-1.3	3.6	-3.1	1.0
Boreal Forest	Upper Boreal Highlands	-4.6	-1.9	2.7	-2.9	1.0
Boreal Forest	Athabasca Plain	-3.0	-1.7	1.3	-2.3	0.3
Boreal Forest	Peace-Athabasca Delta	-2.9	-1.8	1.1	-2.4	0.2
Boreal Forest	Northern Mixedwood	-4.9	-2.5	2.4	-3.3	0.7
Boreal Forest	Boreal Subarctic	-4.9	-2.7	2.2	-3.3	0.4
Canadian Shield	Kazan Uplands	-3.3	-2.1	1.2	-3.0	0.2

Mean Minimum Temperature °C, November

Natural Region	Natural Subregion	Minimum	Maximum	Range	Mean	Standard Deviation
Rocky Mountain	Alpine	-16.3	-7.7	8.6	-13.3	1.1
Rocky Mountain	Subalpine	-15.4	-6.1	9.3	-11.6	1.3
Rocky Mountain	Montane	-13.3	-5.7	7.6	-9.5	1.3
Foothills	Upper Foothills	-13.8	-8.6	5.2	-11.3	0.8
Foothills	Lower Foothills	-13.2	-9.3	3.9	-11.3	0.7
Grassland	Dry Mixedgrass	-11.9	-6.8	5.1	-9.1	1.3
Grassland	Mixedgrass	-11.1	-6.4	4.7	-8.4	1.1
Grassland	Northern Fescue	-11.8	-9.5	2.3	-10.5	0.6
Grassland	Foothills Fescue	-10.2	-6.0	4.2	-8.5	1.3
Parkland	Foothills Parkland	-10.6	-5.7	4.9	-9.3	1.0
Parkland	Central Parkland	-11.7	-8.9	2.8	-10.4	0.6
Parkland	Peace River Parkland	-13.4	-11.1	2.3	-12.0	0.4
Boreal Forest	Dry Mixedwood	-17.3	-9.2	8.1	-12.4	1.8
Boreal Forest	Central Mixedwood	-18.6	-9.6	9.0	-13.2	1.7
Boreal Forest	Lower Boreal Highlands	-18.9	-11.9	7.0	-15.1	1.5
Boreal Forest	Upper Boreal Highlands	-16.8	-13.9	2.9	-15.0	0.7
Boreal Forest	Athabasca Plain	-15.6	-13.4	2.2	-14.7	0.4
Boreal Forest	Peace-Athabasca Delta	-15.4	-14.3	1.1	-14.8	0.3
Boreal Forest	Northern Mixedwood	-18.8	-14.9	3.9	-16.7	1.3
Boreal Forest	Boreal Subarctic	-19.1	-15.5	3.6	-17.2	0.8
Canadian Shield	Kazan Uplands	-16.3	-14.4	1.9	-15.6	0.3

Mean Minimum Temperature °C, December

Natural Region	Natural Subregion	Minimum	Maximum	Range	Mean	Standard Deviation
Rocky Mountain	Alpine	-18.4	-12.1	6.3	-16.8	1.0
Rocky Mountain	Subalpine	-18.6	-10.8	7.8	-16.0	1.4
Rocky Mountain	Montane	-18.6	-10.5	8.1	-14.5	1.4
Foothills	Upper Foothills	-18.5	-13.3	5.2	-16.4	0.8
Foothills	Lower Foothills	-20.2	-14.4	5.8	-17.3	1.1
Grassland	Dry Mixedgrass	-19.1	-11.8	7.3	-15.5	1.8
Grassland	Mixedgrass	-17.1	-11.5	5.6	-14.0	1.4
Grassland	Northern Fescue	-19.1	-15.2	3.9	-17.2	1.1
Grassland	Foothills Fescue	-16.9	-10.8	6.1	-13.8	1.7
Parkland	Foothills Parkland	-15.7	-10.5	5.2	-14.4	1.1
Parkland	Central Parkland	-20.3	-14.0	6.3	-17.5	1.2
Parkland	Peace River Parkland	-20.9	-18.2	2.7	-19.3	0.6
Boreal Forest	Dry Mixedwood	-25.7	-15.2	10.5	-19.9	2.4
Boreal Forest	Central Mixedwood	-27.3	-15.3	12.0	-21.3	2.2
Boreal Forest	Lower Boreal Highlands	-26.9	-19.4	7.5	-22.2	1.5
Boreal Forest	Upper Boreal Highlands	-23.4	-20.2	3.2	-22.1	0.6
Boreal Forest	Athabasca Plain	-26.1	-22.5	3.6	-24.4	0.8
Boreal Forest	Peace-Athabasca Delta	-25.2	-23.7	1.5	-24.4	0.4
Boreal Forest	Northern Mixedwood	-27.2	-23.8	3.4	-25.4	0.9
Boreal Forest	Boreal Subarctic	-26.9	-23.7	3.2	-24.9	0.8
Canadian Shield	Kazan Uplands	-26.8	-23.9	2.9	-25.7	0.5

Mean Maximum Temperature °C, January

Natural Region	Natural Subregion	Minimum	Maximum	Range	Mean	Standard Deviation
Rocky Mountain	Alpine	-10.8	-2.6	8.2	-8.2	0.8
Rocky Mountain	Subalpine	-9.9	-2.5	7.4	-6.5	1.0
Rocky Mountain	Montane	-8.1	-2.1	6.0	-4.0	1.4
Foothills	Upper Foothills	-9.4	-3.2	6.2	-5.6	0.9
Foothills	Lower Foothills	-12.2	-3.2	9.0	-6.9	1.8
Grassland	Dry Mixedgrass	-10.5	-2.2	8.3	-6.6	2.1
Grassland	Mixedgrass	-8.6	-1.5	7.1	-4.5	1.6
Grassland	Northern Fescue	-11.7	-6.6	5.1	-9.1	1.1
Grassland	Foothills Fescue	-8.1	-1.0	7.1	-3.9	1.9
Parkland	Foothills Parkland	-4.4	-1.7	2.7	-3.3	0.6
Parkland	Central Parkland	-12.9	-3.9	9.0	-9.5	1.7
Parkland	Peace River Parkland	-13.5	-8.5	5.0	-10.5	1.3
Boreal Forest	Dry Mixedwood	-17.8	-3.8	14.0	-11.4	2.8
Boreal Forest	Central Mixedwood	-20.4	-5.9	14.5	-13.2	3.1
Boreal Forest	Lower Boreal Highlands	-19.5	-10.9	8.6	-14.8	2.0
Boreal Forest	Upper Boreal Highlands	-17.2	-12.5	4.7	-14.9	1.2
Boreal Forest	Athabasca Plain	-19.8	-14.7	5.1	-17.2	1.1
Boreal Forest	Peace-Athabasca Delta	-20.2	-17.1	3.1	-18.2	0.6
Boreal Forest	Northern Mixedwood	-21.6	-17.2	4.4	-19.1	0.9
Boreal Forest	Boreal Subarctic	-19.5	-17.5	2.0	-18.7	0.4
Canadian Shield	Kazan Uplands	-21.8	-16.2	5.6	-20.3	1.0

Mean Maximum Temperature °C, February

Natural Region	Natural Subregion	Minimum	Maximum	Range	Mean	Standard Deviation
Rocky Mountain	Alpine	-10.7	0.0	10.7	-5.6	1.1
Rocky Mountain	Subalpine	-8.7	0.7	9.4	-3.2	1.1
Rocky Mountain	Montane	-4.5	1.4	5.9	-0.5	1.0
Foothills	Upper Foothills	-5.7	0.6	6.3	-2.0	1.1
Foothills	Lower Foothills	-7.1	0.6	7.7	-3.0	1.7
Grassland	Dry Mixedgrass	-6.9	1.5	8.4	-2.7	2.2
Grassland	Mixedgrass	-4.6	2.0	6.6	-0.8	1.6
Grassland	Northern Fescue	-7.4	-2.7	4.7	-5.1	1.2
Grassland	Foothills Fescue	-3.6	2.1	5.7	-0.4	1.7
Parkland	Foothills Parkland	-1.4	1.3	2.7	0.0	0.5
Parkland	Central Parkland	-8.4	-0.2	8.2	-5.3	1.5
Parkland	Peace River Parkland	-7.8	-4.1	3.7	-5.9	0.9
Boreal Forest	Dry Mixedwood	-11.9	0.2	12.1	-6.6	2.3
Boreal Forest	Central Mixedwood	-15.2	-1.5	13.7	-8.1	2.7
Boreal Forest	Lower Boreal Highlands	-14.9	-5.9	9.0	-9.4	1.9
Boreal Forest	Upper Boreal Highlands	-12.6	-7.7	4.9	-9.9	1.2
Boreal Forest	Athabasca Plain	-14.5	-9.5	5.0	-11.8	1.1
Boreal Forest	Peace-Athabasca Delta	-15.0	-11.2	3.8	-12.7	0.7
Boreal Forest	Northern Mixedwood	-16.6	-11.3	5.3	-13.8	1.1
Boreal Forest	Boreal Subarctic	-15.4	-12.3	3.1	-14.0	0.4
Canadian Shield	Kazan Uplands	-16.8	-10.8	6.0	-15.1	1.1

Mean Maximum Temperature °C, March						
Natural Region	Natural Subregion	Minimum	Maximum	Range	Mean	Standard Deviation
Rocky Mountain	Alpine	-12.0	3.8	15.8	-3.8	1.7
Rocky Mountain	Subalpine	-8.5	4.2	12.7	-0.4	1.4
Rocky Mountain	Montane	-2.7	4.6	7.3	2.7	0.9
Foothills	Upper Foothills	-3.4	3.8	7.2	1.7	1.0
Foothills	Lower Foothills	-1.8	4.1	5.9	1.8	1.3
Grassland	Dry Mixedgrass	-0.8	5.7	6.5	3.0	1.6
Grassland	Mixedgrass	0.1	5.9	5.8	3.8	1.2
Grassland	Northern Fescue	-1.5	2.9	4.4	0.6	0.9
Grassland	Foothills Fescue	1.2	5.6	4.4	3.3	1.0
Parkland	Foothills Parkland	1.8	4.5	2.7	3.2	0.4
Parkland	Central Parkland	-2.1	3.4	5.5	0.1	1.0
Parkland	Peace River Parkland	-1.1	1.8	2.9	0.0	0.5
Boreal Forest	Dry Mixedwood	-4.3	3.8	8.1	-0.3	1.5
Boreal Forest	Central Mixedwood	-7.2	3.3	10.5	-1.4	1.9
Boreal Forest	Lower Boreal Highlands	-9.1	0.1	9.2	-2.9	1.7
Boreal Forest	Upper Boreal Highlands	-6.4	-1.6	4.8	-3.9	1.0
Boreal Forest	Athabasca Plain	-6.3	-1.9	4.4	-4.0	0.8
Boreal Forest	Peace-Athabasca Delta	-6.7	-3.4	3.3	-4.7	0.6
Boreal Forest	Northern Mixedwood	-8.4	-3.7	4.7	-6.3	1.0
Boreal Forest	Boreal Subarctic	-10.3	-5.3	5.0	-8.0	0.7
Canadian Shield	Kazan Uplands	-8.8	-3.2	5.6	-7.0	1.0

Mean Maximum Temperature °C, April						
Natural Region	Natural Subregion	Minimum	Maximum	Range	Mean	Standard Deviation
Rocky Mountain	Alpine	-9.2	9.3	18.5	0.6	1.9
Rocky Mountain	Subalpine	-5.1	10.3	15.4	4.7	1.7
Rocky Mountain	Montane	1.8	11.0	9.2	8.2	1.0
Foothills	Upper Foothills	1.4	10.2	8.8	7.9	0.9
Foothills	Lower Foothills	5.9	11.2	5.3	9.3	0.9
Grassland	Dry Mixedgrass	9.7	13.6	3.9	12.0	0.7
Grassland	Mixedgrass	7.2	13.0	5.8	11.5	0.8
Grassland	Northern Fescue	8.8	12.6	3.8	10.5	0.6
Grassland	Foothills Fescue	7.6	12.2	4.6	10.4	0.6
Parkland	Foothills Parkland	7.0	10.5	3.5	9.4	0.5
Parkland	Central Parkland	8.6	11.9	3.3	9.9	0.4
Parkland	Peace River Parkland	8.5	12.2	3.7	9.7	0.6
Boreal Forest	Dry Mixedwood	6.6	12.3	5.7	9.5	0.7
Boreal Forest	Central Mixedwood	4.1	11.2	7.1	8.4	1.1
Boreal Forest	Lower Boreal Highlands	1.3	9.1	7.8	6.9	1.3
Boreal Forest	Upper Boreal Highlands	3.8	7.5	3.7	5.5	0.6
Boreal Forest	Athabasca Plain	5.1	9.5	4.4	7.0	0.8
Boreal Forest	Peace-Athabasca Delta	5.1	7.9	2.8	6.8	0.5
Boreal Forest	Northern Mixedwood	3.6	7.5	3.9	5.0	0.9
Boreal Forest	Boreal Subarctic	-0.1	5.1	5.2	2.4	0.8
Canadian Shield	Kazan Uplands	2.9	7.7	4.8	4.6	0.9

Mean Maximum Temperature °C, May

Natural Region	Natural Subregion	Minimum	Maximum	Range	Mean	Standard Deviation
Rocky Mountain	Alpine	-5.1	14.8	19.9	5.2	2.1
Rocky Mountain	Subalpine	-0.9	16.0	16.9	9.8	1.9
Rocky Mountain	Montane	6.6	16.8	10.2	13.7	1.1
Foothills	Upper Foothills	6.5	15.8	9.3	13.3	0.9
Foothills	Lower Foothills	12.1	17.2	5.1	15.3	0.7
Grassland	Dry Mixedgrass	16.4	20.2	3.8	18.6	0.5
Grassland	Mixedgrass	13.7	19.5	5.8	17.6	0.7
Grassland	Northern Fescue	16.3	19.5	3.2	17.8	0.4
Grassland	Foothills Fescue	13.4	18.1	4.7	16.3	0.8
Parkland	Foothills Parkland	12.6	16.2	3.6	14.9	0.5
Parkland	Central Parkland	14.9	18.9	4.0	17.4	0.5
Parkland	Peace River Parkland	15.5	20.0	4.5	16.9	0.7
Boreal Forest	Dry Mixedwood	14.4	20.1	5.7	16.9	0.6
Boreal Forest	Central Mixedwood	13.1	18.1	5.0	16.1	0.7
Boreal Forest	Lower Boreal Highlands	10.4	16.8	6.4	14.6	0.9
Boreal Forest	Upper Boreal Highlands	11.9	14.9	3.0	13.3	0.5
Boreal Forest	Athabasca Plain	13.9	17.5	3.6	15.8	0.6
Boreal Forest	Peace-Athabasca Delta	14.4	16.4	2.0	15.4	0.4
Boreal Forest	Northern Mixedwood	12.9	16.8	3.9	14.5	1.1
Boreal Forest	Boreal Subarctic	9.6	14.3	4.7	11.7	0.9
Canadian Shield	Kazan Uplands	12.5	16.4	3.9	14.0	0.6

Mean Maximum Temperature °C, June

Natural Region	Natural Subregion	Minimum	Maximum	Range	Mean	Standard Deviation
Rocky Mountain	Alpine	-0.3	18.8	19.1	9.6	2.1
Rocky Mountain	Subalpine	3.7	19.8	16.1	14.0	1.8
Rocky Mountain	Montane	11.3	20.9	9.6	18.0	1.0
Foothills	Upper Foothills	10.1	19.3	9.2	17.1	0.8
Foothills	Lower Foothills	15.5	20.6	5.1	18.8	0.6
Grassland	Dry Mixedgrass	21.5	24.9	3.4	23.1	0.5
Grassland	Mixedgrass	18.0	23.5	5.5	22.0	0.6
Grassland	Northern Fescue	20.2	23.5	3.3	21.9	0.4
Grassland	Foothills Fescue	17.8	22.5	4.7	20.7	0.7
Parkland	Foothills Parkland	17.2	20.5	3.3	19.1	0.5
Parkland	Central Parkland	18.8	23.0	4.2	21.1	0.5
Parkland	Peace River Parkland	19.0	23.5	4.5	20.5	0.8
Boreal Forest	Dry Mixedwood	17.7	23.5	5.8	20.6	0.6
Boreal Forest	Central Mixedwood	18.1	22.2	4.1	20.2	0.7
Boreal Forest	Lower Boreal Highlands	16.4	20.8	4.4	18.9	0.7
Boreal Forest	Upper Boreal Highlands	16.0	19.1	3.1	17.7	0.6
Boreal Forest	Athabasca Plain	18.6	22.0	3.4	20.9	0.6
Boreal Forest	Peace-Athabasca Delta	20.5	21.5	1.0	21.1	0.2
Boreal Forest	Northern Mixedwood	18.4	21.5	3.1	20.2	0.6
Boreal Forest	Boreal Subarctic	15.1	19.1	4.0	17.0	0.8
Canadian Shield	Kazan Uplands	18.7	21.1	2.4	20.0	0.4

Mean Maximum Temperature °C, July

Natural Region	Natural Subregion	Minimum	Maximum	Range	Mean	Standard Deviation
Rocky Mountain	Alpine	3.3	22.2	18.9	12.9	2.1
Rocky Mountain	Subalpine	7.2	22.8	15.6	17.0	1.8
Rocky Mountain	Montane	14.9	24.0	9.1	21.2	1.0
Foothills	Upper Foothills	13.1	21.8	8.7	19.5	0.7
Foothills	Lower Foothills	17.7	22.4	4.7	20.9	0.6
Grassland	Dry Mixedgrass	24.1	28.6	4.5	26.2	0.7
Grassland	Mixedgrass	21.0	27.3	6.3	25.1	0.7
Grassland	Northern Fescue	22.4	26.1	3.7	24.3	0.5
Grassland	Foothills Fescue	21.5	26.0	4.5	23.8	0.8
Parkland	Foothills Parkland	20.8	23.6	2.8	22.1	0.5
Parkland	Central Parkland	21.4	25.4	4.0	23.0	0.6
Parkland	Peace River Parkland	21.0	25.5	4.5	22.4	0.8
Boreal Forest	Dry Mixedwood	19.6	25.6	6.0	22.4	0.6
Boreal Forest	Central Mixedwood	20.1	24.0	3.9	22.0	0.7
Boreal Forest	Lower Boreal Highlands	18.1	22.7	4.6	20.7	0.7
Boreal Forest	Upper Boreal Highlands	17.9	20.7	2.8	19.4	0.5
Boreal Forest	Athabasca Plain	20.3	23.8	3.5	22.8	0.7
Boreal Forest	Peace-Athabasca Delta	22.7	23.4	0.7	23.2	0.1
Boreal Forest	Northern Mixedwood	20.2	23.3	3.1	22.1	0.6
Boreal Forest	Boreal Subarctic	17.0	20.9	3.9	18.8	0.9
Canadian Shield	Kazan Uplands	21.1	23.1	2.0	22.3	0.4

Mean Maximum Temperature °C, August

Natural Region	Natural Subregion	Minimum	Maximum	Range	Mean	Standard Deviation
Rocky Mountain	Alpine	3.2	21.8	18.6	12.5	2.0
Rocky Mountain	Subalpine	7.0	22.2	15.2	16.5	1.8
Rocky Mountain	Montane	14.3	23.6	9.3	20.6	1.0
Foothills	Upper Foothills	12.5	21.0	8.5	18.7	0.8
Foothills	Lower Foothills	16.7	21.7	5.0	19.9	0.7
Grassland	Dry Mixedgrass	23.6	28.1	4.5	25.7	0.7
Grassland	Mixedgrass	21.0	26.9	5.9	24.6	0.7
Grassland	Northern Fescue	22.1	25.4	3.3	23.7	0.5
Grassland	Foothills Fescue	20.9	25.5	4.6	23.3	0.8
Parkland	Foothills Parkland	20.3	23.2	2.9	21.5	0.5
Parkland	Central Parkland	20.7	24.6	3.9	22.3	0.6
Parkland	Peace River Parkland	20.1	24.3	4.2	21.4	0.6
Boreal Forest	Dry Mixedwood	19.0	24.4	5.4	21.2	0.5
Boreal Forest	Central Mixedwood	18.5	22.7	4.2	20.5	0.5
Boreal Forest	Lower Boreal Highlands	16.0	20.8	4.8	19.1	0.7
Boreal Forest	Upper Boreal Highlands	16.2	19.2	3.0	17.9	0.4
Boreal Forest	Athabasca Plain	18.5	22.1	3.6	20.9	0.6
Boreal Forest	Peace-Athabasca Delta	20.4	21.5	1.1	21.0	0.2
Boreal Forest	Northern Mixedwood	18.0	21.4	3.4	19.8	0.6
Boreal Forest	Boreal Subarctic	14.8	18.8	4.0	16.7	0.8
Canadian Shield	Kazan Uplands	18.8	21.0	2.2	20.0	0.4

Mean Maximum Temperature °C, September

Natural Region	Natural Subregion	Minimum	Maximum	Range	Mean	Standard Deviation
Rocky Mountain	Alpine	-1.0	16.5	17.5	7.7	1.9
Rocky Mountain	Subalpine	2.6	16.4	13.8	11.6	1.6
Rocky Mountain	Montane	9.5	18.0	8.5	15.5	0.9
Foothills	Upper Foothills	8.5	15.9	7.4	13.7	0.8
Foothills	Lower Foothills	11.6	16.6	5.0	14.9	0.9
Grassland	Dry Mixedgrass	17.4	21.2	3.8	19.4	0.6
Grassland	Mixedgrass	15.8	20.5	4.7	18.8	0.6
Grassland	Northern Fescue	16.2	19.4	3.2	17.7	0.5
Grassland	Foothills Fescue	15.7	19.6	3.9	17.7	0.6
Parkland	Foothills Parkland	15.2	17.4	2.2	16.4	0.3
Parkland	Central Parkland	15.1	18.7	3.6	16.5	0.5
Parkland	Peace River Parkland	14.9	18.5	3.6	15.9	0.5
Boreal Forest	Dry Mixedwood	13.3	18.6	5.3	15.6	0.6
Boreal Forest	Central Mixedwood	12.1	16.8	4.7	14.5	0.6
Boreal Forest	Lower Boreal Highlands	10.0	15.1	5.1	13.2	0.7
Boreal Forest	Upper Boreal Highlands	10.7	13.6	2.9	12.1	0.4
Boreal Forest	Athabasca Plain	11.7	15.3	3.6	13.5	0.5
Boreal Forest	Peace-Athabasca Delta	13.0	14.5	1.5	13.9	0.3
Boreal Forest	Northern Mixedwood	11.6	15.5	3.9	13.3	0.9
Boreal Forest	Boreal Subarctic	9.4	12.9	3.5	10.9	0.6
Canadian Shield	Kazan Uplands	10.9	13.8	2.9	12.3	0.6

Mean Maximum Temperature °C, October

Natural Region	Natural Subregion	Minimum	Maximum	Range	Mean	Standard Deviation
Rocky Mountain	Alpine	-5.1	10.8	15.9	2.8	1.7
Rocky Mountain	Subalpine	-2.3	11.1	13.4	6.4	1.7
Rocky Mountain	Montane	4.6	12.6	8.0	10.3	1.1
Foothills	Upper Foothills	3.4	11.8	8.4	9.2	1.0
Foothills	Lower Foothills	6.8	12.1	5.3	10.0	1.1
Grassland	Dry Mixedgrass	11.1	15.1	4.0	13.5	0.9
Grassland	Mixedgrass	9.7	15.0	5.3	13.4	0.8
Grassland	Northern Fescue	10.3	13.6	3.3	11.9	0.6
Grassland	Foothills Fescue	10.7	14.6	3.9	12.7	0.5
Parkland	Foothills Parkland	9.9	12.6	2.7	11.8	0.3
Parkland	Central Parkland	9.5	13.1	3.6	11.0	0.6
Parkland	Peace River Parkland	9.0	11.5	2.5	10.1	0.4
Boreal Forest	Dry Mixedwood	6.3	12.2	5.9	9.6	1.2
Boreal Forest	Central Mixedwood	4.4	11.8	7.4	8.1	1.4
Boreal Forest	Lower Boreal Highlands	2.4	8.9	6.5	6.5	1.2
Boreal Forest	Upper Boreal Highlands	3.7	7.4	3.7	5.5	0.7
Boreal Forest	Athabasca Plain	4.6	7.9	3.3	6.1	0.6
Boreal Forest	Peace-Athabasca Delta	4.8	6.8	2.0	6.1	0.4
Boreal Forest	Northern Mixedwood	3.1	6.2	3.1	4.8	0.5
Boreal Forest	Boreal Subarctic	1.3	4.9	3.6	2.9	0.4
Canadian Shield	Kazan Uplands	2.9	6.7	3.8	4.3	0.7

Mean Maximum Temperature °C, November						
Natural Region	**Natural Subregion**	**Minimum**	**Maximum**	**Range**	**Mean**	**Standard Deviation**
Rocky Mountain	Alpine	-10.9	2.4	13.3	-5.1	1.3
Rocky Mountain	Subalpine	-8.5	2.8	11.3	-2.1	1.4
Rocky Mountain	Montane	-4.0	3.7	7.7	1.6	1.3
Foothills	Upper Foothills	-4.2	2.7	6.9	-0.1	0.9
Foothills	Lower Foothills	-4.0	2.8	6.8	-0.3	1.4
Grassland	Dry Mixedgrass	-0.6	5.1	5.7	2.5	1.5
Grassland	Mixedgrass	0.5	5.1	4.6	3.2	1.1
Grassland	Northern Fescue	-1.3	2.1	3.4	0.4	0.7
Grassland	Foothills Fescue	1.3	4.9	3.6	3.1	0.9
Parkland	Foothills Parkland	1.6	3.9	2.3	2.8	0.3
Parkland	Central Parkland	-2.7	2.8	5.5	-0.5	1.1
Parkland	Peace River Parkland	-3.8	-0.5	3.3	-2.1	0.7
Boreal Forest	Dry Mixedwood	-8.1	2.8	10.9	-2.7	2.1
Boreal Forest	Central Mixedwood	-9.1	1.3	10.4	-4.1	2.0
Boreal Forest	Lower Boreal Highlands	-10.7	-2.8	7.9	-5.9	1.6
Boreal Forest	Upper Boreal Highlands	-7.8	-4.5	3.3	-6.3	0.7
Boreal Forest	Athabasca Plain	-7.6	-5.0	2.6	-6.3	0.5
Boreal Forest	Peace-Athabasca Delta	-7.8	-5.8	2.0	-6.5	0.4
Boreal Forest	Northern Mixedwood	-10.3	-6.9	3.4	-8.4	0.7
Boreal Forest	Boreal Subarctic	-11.0	-7.6	3.4	-9.5	0.6
Canadian Shield	Kazan Uplands	-9.1	-5.8	3.3	-8.0	0.6

Mean Maximum Temperature °C, December						
Natural Region	**Natural Subregion**	**Minimum**	**Maximum**	**Range**	**Mean**	**Standard Deviation**
Rocky Mountain	Alpine	-11.2	-2.0	9.2	-8.1	1.0
Rocky Mountain	Subalpine	-10.2	-1.5	8.7	-6.0	1.3
Rocky Mountain	Montane	-8.0	-0.8	7.2	-3.1	1.5
Foothills	Upper Foothills	-7.8	-1.9	5.9	-4.5	0.8
Foothills	Lower Foothills	-9.8	-1.9	7.9	-5.6	1.6
Grassland	Dry Mixedgrass	-8.2	-0.5	7.7	-4.5	1.9
Grassland	Mixedgrass	-5.9	-0.1	5.8	-2.7	1.4
Grassland	Northern Fescue	-8.5	-4.5	4.0	-6.5	1.2
Grassland	Foothills Fescue	-5.6	0.0	5.6	-2.3	1.6
Parkland	Foothills Parkland	-3.5	-0.6	2.9	-2.1	0.5
Parkland	Central Parkland	-10.5	-2.5	8.0	-7.3	1.5
Parkland	Peace River Parkland	-10.7	-7.0	3.7	-8.5	1.0
Boreal Forest	Dry Mixedwood	-15.5	-2.5	13.0	-9.4	2.5
Boreal Forest	Central Mixedwood	-17.0	-4.6	12.4	-11.0	2.7
Boreal Forest	Lower Boreal Highlands	-16.8	-8.8	8.0	-12.1	1.8
Boreal Forest	Upper Boreal Highlands	-14.5	-10.4	4.1	-12.3	1.1
Boreal Forest	Athabasca Plain	-16.4	-12.7	3.7	-14.3	0.7
Boreal Forest	Peace-Athabasca Delta	-16.8	-14.1	2.7	-15.0	0.5
Boreal Forest	Northern Mixedwood	-18.2	-13.8	4.4	-16.2	0.7
Boreal Forest	Boreal Subarctic	-16.9	-14.4	2.5	-16.1	0.4
Canadian Shield	Kazan Uplands	-18.1	-13.7	4.4	-16.8	0.9

Mean Daily Temperature °C, January

Natural Region	Natural Subregion	Minimum	Maximum	Range	Mean	Standard Deviation
Rocky Mountain	Alpine	-13.9	-8.6	5.3	-12.5	0.7
Rocky Mountain	Subalpine	-14.0	-7.4	6.6	-11.7	1.0
Rocky Mountain	Montane	-13.9	-7.2	6.7	-10.0	1.2
Foothills	Upper Foothills	-14.5	-9.8	4.7	-11.6	0.6
Foothills	Lower Foothills	-17.6	-9.9	7.7	-12.8	1.5
Grassland	Dry Mixedgrass	-16.1	-7.9	8.2	-12.1	2.0
Grassland	Mixedgrass	-14.0	-7.4	6.6	-10.2	1.5
Grassland	Northern Fescue	-16.6	-11.9	4.7	-14.3	1.1
Grassland	Foothills Fescue	-13.7	-6.9	6.8	-9.7	1.9
Parkland	Foothills Parkland	-10.7	-7.2	3.5	-9.6	0.7
Parkland	Central Parkland	-17.9	-9.8	8.1	-14.7	1.5
Parkland	Peace River Parkland	-18.9	-14.1	4.8	-15.9	1.1
Boreal Forest	Dry Mixedwood	-22.5	-10.5	12.0	-16.8	2.7
Boreal Forest	Central Mixedwood	-24.5	-11.3	13.2	-18.7	2.8
Boreal Forest	Lower Boreal Highlands	-24.4	-16.4	8.0	-20.0	1.8
Boreal Forest	Upper Boreal Highlands	-22.0	-17.3	4.7	-19.9	1.0
Boreal Forest	Athabasca Plain	-25.2	-20.3	4.9	-22.7	1.1
Boreal Forest	Peace-Athabasca Delta	-24.7	-22.4	2.3	-23.3	0.5
Boreal Forest	Northern Mixedwood	-25.6	-22.4	3.2	-23.8	0.5
Boreal Forest	Boreal Subarctic	-24.3	-22.1	2.2	-23.1	0.5
Canadian Shield	Kazan Uplands	-26.5	-21.9	4.6	-25.1	0.8

Mean Daily Temperature °C, February

Natural Region	Natural Subregion	Minimum	Maximum	Range	Mean	Standard Deviation
Rocky Mountain	Alpine	-13.1	-5.9	7.2	-10.2	0.8
Rocky Mountain	Subalpine	-12.0	-4.5	7.5	-8.8	0.8
Rocky Mountain	Montane	-9.7	-4.2	5.5	-6.8	0.9
Foothills	Upper Foothills	-11.4	-6.5	4.9	-8.6	0.7
Foothills	Lower Foothills	-13.4	-6.5	6.9	-9.5	1.3
Grassland	Dry Mixedgrass	-12.5	-4.5	8.0	-8.4	2.1
Grassland	Mixedgrass	-10.0	-4.0	6.0	-6.5	1.5
Grassland	Northern Fescue	-12.6	-8.4	4.2	-10.6	1.2
Grassland	Foothills Fescue	-9.2	-3.9	5.3	-6.3	1.6
Parkland	Foothills Parkland	-7.1	-4.2	2.9	-6.4	0.6
Parkland	Central Parkland	-14.0	-6.6	7.4	-10.8	1.4
Parkland	Peace River Parkland	-13.9	-10.4	3.5	-11.7	0.8
Boreal Forest	Dry Mixedwood	-18.2	-6.9	11.3	-12.7	2.5
Boreal Forest	Central Mixedwood	-20.2	-8.3	11.9	-14.4	2.6
Boreal Forest	Lower Boreal Highlands	-20.7	-12.5	8.2	-15.6	1.8
Boreal Forest	Upper Boreal Highlands	-18.0	-13.6	4.4	-15.8	1.1
Boreal Forest	Athabasca Plain	-20.7	-16.0	4.7	-18.3	1.0
Boreal Forest	Peace-Athabasca Delta	-20.3	-17.7	2.6	-18.7	0.5
Boreal Forest	Northern Mixedwood	-21.4	-17.2	4.2	-19.7	0.7
Boreal Forest	Boreal Subarctic	-20.8	-17.9	2.9	-19.5	0.5
Canadian Shield	Kazan Uplands	-22.2	-17.5	4.7	-20.7	0.8

Mean Daily Temperature °C, March						
Natural Region	**Natural Subregion**	**Minimum**	**Maximum**	**Range**	**Mean**	**Standard Deviation**
Rocky Mountain	Alpine	-14.3	-2.4	11.9	-8.6	1.3
Rocky Mountain	Subalpine	-12.0	-2.0	10.0	-6.0	1.1
Rocky Mountain	Montane	-7.9	-1.2	6.7	-3.5	0.8
Foothills	Upper Foothills	-7.8	-3.0	4.8	-4.7	0.6
Foothills	Lower Foothills	-7.7	-2.6	5.1	-4.5	1.0
Grassland	Dry Mixedgrass	-6.3	-0.4	5.9	-2.8	1.5
Grassland	Mixedgrass	-5.1	-0.3	4.8	-2.1	1.1
Grassland	Northern Fescue	-6.7	-3.4	3.3	-5.0	0.8
Grassland	Foothills Fescue	-4.4	-0.5	3.9	-2.4	1.0
Parkland	Foothills Parkland	-4.1	-1.4	2.7	-3.0	0.4
Parkland	Central Parkland	-7.5	-2.7	4.8	-5.3	0.9
Parkland	Peace River Parkland	-7.4	-4.6	2.8	-6.0	0.5
Boreal Forest	Dry Mixedwood	-10.8	-3.1	7.7	-6.6	1.7
Boreal Forest	Central Mixedwood	-13.1	-3.2	9.9	-7.9	2.1
Boreal Forest	Lower Boreal Highlands	-15.1	-6.5	8.6	-9.4	1.7
Boreal Forest	Upper Boreal Highlands	-12.3	-8.0	4.3	-10.1	0.9
Boreal Forest	Athabasca Plain	-13.2	-9.1	4.1	-11.1	0.8
Boreal Forest	Peace-Athabasca Delta	-12.8	-10.5	2.3	-11.4	0.4
Boreal Forest	Northern Mixedwood	-14.2	-10.7	3.5	-12.9	0.7
Boreal Forest	Boreal Subarctic	-15.9	-11.8	4.1	-14.0	0.5
Canadian Shield	Kazan Uplands	-15.2	-10.4	4.8	-13.4	0.9

Mean Daily Temperature °C, April						
Natural Region	**Natural Subregion**	**Minimum**	**Maximum**	**Range**	**Mean**	**Standard Deviation**
Rocky Mountain	Alpine	-10.7	3.0	13.7	-3.8	1.4
Rocky Mountain	Subalpine	-7.8	3.3	11.1	-0.7	1.3
Rocky Mountain	Montane	-3.0	4.1	7.1	2.0	0.8
Foothills	Upper Foothills	-2.8	3.2	6.0	1.5	0.7
Foothills	Lower Foothills	0.6	4.3	3.7	2.8	0.6
Grassland	Dry Mixedgrass	3.2	6.4	3.2	5.1	0.6
Grassland	Mixedgrass	1.7	6.1	4.4	4.8	0.7
Grassland	Northern Fescue	2.8	5.3	2.5	3.9	0.3
Grassland	Foothills Fescue	1.9	5.5	3.6	4.0	0.5
Parkland	Foothills Parkland	1.5	3.9	2.4	2.9	0.4
Parkland	Central Parkland	2.7	4.9	2.2	3.8	0.3
Parkland	Peace River Parkland	2.6	4.8	2.2	3.4	0.3
Boreal Forest	Dry Mixedwood	0.6	4.9	4.3	3.1	0.7
Boreal Forest	Central Mixedwood	-1.7	4.6	6.3	2.1	1.0
Boreal Forest	Lower Boreal Highlands	-3.8	2.8	6.6	0.8	1.1
Boreal Forest	Upper Boreal Highlands	-1.5	1.4	2.9	-0.1	0.5
Boreal Forest	Athabasca Plain	-0.9	2.3	3.2	0.6	0.6
Boreal Forest	Peace-Athabasca Delta	-0.6	1.3	1.9	0.6	0.4
Boreal Forest	Northern Mixedwood	-2.3	0.8	3.1	-1.1	0.7
Boreal Forest	Boreal Subarctic	-4.8	-0.7	4.1	-2.8	0.6
Canadian Shield	Kazan Uplands	-2.8	1.1	3.9	-1.2	0.7

Mean Daily Temperature °C, May

Natural Region	Natural Subregion	Minimum	Maximum	Range	Mean	Standard Deviation
Rocky Mountain	Alpine	-4.8	7.9	12.7	1.7	1.3
Rocky Mountain	Subalpine	-2.1	8.4	10.5	4.7	1.3
Rocky Mountain	Montane	2.5	9.4	6.9	7.2	0.8
Foothills	Upper Foothills	2.9	8.7	5.8	7.3	0.7
Foothills	Lower Foothills	6.2	10.1	3.9	8.9	0.5
Grassland	Dry Mixedgrass	9.5	12.5	3.0	11.4	0.4
Grassland	Mixedgrass	7.9	11.8	3.9	10.6	0.6
Grassland	Northern Fescue	9.7	11.8	2.1	10.6	0.3
Grassland	Foothills Fescue	7.3	11.0	3.7	9.5	0.6
Parkland	Foothills Parkland	6.6	9.5	2.9	8.2	0.5
Parkland	Central Parkland	8.4	11.5	3.1	10.5	0.5
Parkland	Peace River Parkland	9.3	11.6	2.3	10.1	0.4
Boreal Forest	Dry Mixedwood	8.1	11.6	3.5	10.0	0.5
Boreal Forest	Central Mixedwood	7.4	10.9	3.5	9.6	0.4
Boreal Forest	Lower Boreal Highlands	5.8	10.1	4.3	8.6	0.7
Boreal Forest	Upper Boreal Highlands	6.8	9.1	2.3	7.8	0.4
Boreal Forest	Athabasca Plain	8.3	10.3	2.0	9.5	0.4
Boreal Forest	Peace-Athabasca Delta	8.4	9.8	1.4	9.1	0.3
Boreal Forest	Northern Mixedwood	7.1	9.4	2.3	8.1	0.6
Boreal Forest	Boreal Subarctic	5.2	8.0	2.8	6.6	0.5
Canadian Shield	Kazan Uplands	6.9	10.0	3.1	8.0	0.5

Mean Daily Temperature °C, June

Natural Region	Natural Subregion	Minimum	Maximum	Range	Mean	Standard Deviation
Rocky Mountain	Alpine	-1.0	11.9	12.9	5.6	1.4
Rocky Mountain	Subalpine	1.7	12.3	10.6	8.6	1.3
Rocky Mountain	Montane	6.8	14.1	7.3	11.2	0.8
Foothills	Upper Foothills	6.2	12.5	6.3	11.1	0.7
Foothills	Lower Foothills	10.2	13.8	3.6	12.6	0.5
Grassland	Dry Mixedgrass	14.3	17.2	2.9	15.9	0.5
Grassland	Mixedgrass	12.1	16.3	4.2	15.0	0.5
Grassland	Northern Fescue	13.8	16.1	2.3	14.9	0.3
Grassland	Foothills Fescue	11.3	15.4	4.1	13.7	0.6
Parkland	Foothills Parkland	10.6	13.7	3.1	12.3	0.5
Parkland	Central Parkland	12.4	15.7	3.3	14.6	0.5
Parkland	Peace River Parkland	12.9	15.6	2.7	14.0	0.5
Boreal Forest	Dry Mixedwood	11.9	15.7	3.8	14.0	0.5
Boreal Forest	Central Mixedwood	12.0	15.2	3.2	13.9	0.5
Boreal Forest	Lower Boreal Highlands	11.4	14.2	2.8	13.0	0.5
Boreal Forest	Upper Boreal Highlands	11.2	13.4	2.2	12.3	0.4
Boreal Forest	Athabasca Plain	13.2	15.3	2.1	14.7	0.4
Boreal Forest	Peace-Athabasca Delta	14.5	15.2	0.7	15.0	0.2
Boreal Forest	Northern Mixedwood	12.4	14.7	2.3	13.8	0.5
Boreal Forest	Boreal Subarctic	10.4	13.0	2.6	11.7	0.4
Canadian Shield	Kazan Uplands	13.1	14.9	1.8	14.0	0.3

Mean Daily Temperature °C, July

Natural Region	Natural Subregion	Minimum	Maximum	Range	Mean	Standard Deviation
Rocky Mountain	Alpine	2.8	14.7	11.9	8.6	1.3
Rocky Mountain	Subalpine	5.2	15.4	10.2	11.3	1.2
Rocky Mountain	Montane	10.0	16.6	6.6	13.9	0.8
Foothills	Upper Foothills	9.2	14.6	5.4	13.4	0.6
Foothills	Lower Foothills	12.6	15.8	3.2	14.7	0.4
Grassland	Dry Mixedgrass	17.0	19.8	2.8	18.5	0.5
Grassland	Mixedgrass	15.0	19.1	4.1	17.6	0.5
Grassland	Northern Fescue	16.1	18.4	2.3	17.2	0.3
Grassland	Foothills Fescue	14.0	18.1	4.1	16.3	0.6
Parkland	Foothills Parkland	13.2	16.1	2.9	14.7	0.5
Parkland	Central Parkland	14.6	17.7	3.1	16.5	0.5
Parkland	Peace River Parkland	14.9	17.4	2.5	15.9	0.5
Boreal Forest	Dry Mixedwood	14.1	17.5	3.4	15.9	0.5
Boreal Forest	Central Mixedwood	14.0	17.3	3.3	15.9	0.5
Boreal Forest	Lower Boreal Highlands	13.5	16.2	2.7	15.0	0.4
Boreal Forest	Upper Boreal Highlands	13.3	15.4	2.1	14.3	0.4
Boreal Forest	Athabasca Plain	15.3	17.5	2.2	17.0	0.5
Boreal Forest	Peace-Athabasca Delta	16.9	17.4	0.5	17.2	0.1
Boreal Forest	Northern Mixedwood	14.6	17.0	2.4	15.9	0.5
Boreal Forest	Boreal Subarctic	12.6	14.9	2.3	13.8	0.5
Canadian Shield	Kazan Uplands	15.9	17.2	1.3	16.6	0.2

Mean Daily Temperature °C, August

Natural Region	Natural Subregion	Minimum	Maximum	Range	Mean	Standard Deviation
Rocky Mountain	Alpine	3.3	14.1	10.8	8.5	1.1
Rocky Mountain	Subalpine	5.4	14.9	9.5	10.9	1.1
Rocky Mountain	Montane	9.6	16.2	6.6	13.3	0.8
Foothills	Upper Foothills	8.8	13.7	4.9	12.6	0.5
Foothills	Lower Foothills	12.0	14.9	2.9	13.7	0.4
Grassland	Dry Mixedgrass	16.2	19.2	3.0	17.8	0.6
Grassland	Mixedgrass	14.7	18.6	3.9	17.0	0.5
Grassland	Northern Fescue	15.4	17.5	2.1	16.3	0.3
Grassland	Foothills Fescue	13.5	17.6	4.1	15.8	0.6
Parkland	Foothills Parkland	12.7	15.5	2.8	14.2	0.5
Parkland	Central Parkland	14.1	16.8	2.7	15.6	0.4
Parkland	Peace River Parkland	14.0	16.1	2.1	14.7	0.4
Boreal Forest	Dry Mixedwood	13.3	16.1	2.8	14.7	0.4
Boreal Forest	Central Mixedwood	13.0	15.6	2.6	14.3	0.4
Boreal Forest	Lower Boreal Highlands	11.6	14.8	3.2	13.4	0.5
Boreal Forest	Upper Boreal Highlands	11.8	13.8	2.0	12.8	0.3
Boreal Forest	Athabasca Plain	13.6	15.4	1.8	15.0	0.3
Boreal Forest	Peace-Athabasca Delta	14.4	15.4	1.0	14.9	0.2
Boreal Forest	Northern Mixedwood	12.5	14.6	2.1	13.6	0.4
Boreal Forest	Boreal Subarctic	10.9	13.2	2.3	11.9	0.4
Canadian Shield	Kazan Uplands	13.8	15.0	1.2	14.4	0.3

Mean Daily Temperature °C, September

Natural Region	Natural Subregion	Minimum	Maximum	Range	Mean	Standard Deviation
Rocky Mountain	Alpine	-0.4	9.3	9.7	4.3	1.0
Rocky Mountain	Subalpine	1.5	10.0	8.5	6.5	1.0
Rocky Mountain	Montane	5.3	10.8	5.5	8.7	0.7
Foothills	Upper Foothills	5.1	9.2	4.1	8.1	0.4
Foothills	Lower Foothills	7.6	10.1	2.5	9.0	0.4
Grassland	Dry Mixedgrass	10.4	13.2	2.8	11.9	0.5
Grassland	Mixedgrass	9.4	13.0	3.6	11.5	0.5
Grassland	Northern Fescue	9.9	11.8	1.9	10.7	0.3
Grassland	Foothills Fescue	8.9	12.1	3.2	10.6	0.5
Parkland	Foothills Parkland	8.2	10.6	2.4	9.4	0.4
Parkland	Central Parkland	9.2	11.2	2.0	10.1	0.3
Parkland	Peace River Parkland	9.2	10.7	1.5	9.7	0.2
Boreal Forest	Dry Mixedwood	8.1	10.8	2.7	9.4	0.4
Boreal Forest	Central Mixedwood	7.5	10.3	2.8	8.8	0.4
Boreal Forest	Lower Boreal Highlands	6.2	9.3	3.1	8.1	0.5
Boreal Forest	Upper Boreal Highlands	6.7	8.5	1.8	7.5	0.2
Boreal Forest	Athabasca Plain	7.6	9.2	1.6	8.6	0.3
Boreal Forest	Peace-Athabasca Delta	8.2	9.0	0.8	8.7	0.2
Boreal Forest	Northern Mixedwood	6.8	8.9	2.1	7.9	0.4
Boreal Forest	Boreal Subarctic	5.7	7.5	1.8	6.5	0.3
Canadian Shield	Kazan Uplands	7.1	8.7	1.6	7.9	0.3

Mean Daily Temperature °C, October

Natural Region	Natural Subregion	Minimum	Maximum	Range	Mean	Standard Deviation
Rocky Mountain	Alpine	-5.6	4.7	10.3	-0.9	1.1
Rocky Mountain	Subalpine	-3.7	5.7	9.4	1.5	1.1
Rocky Mountain	Montane	0.1	6.3	6.2	4.0	0.8
Foothills	Upper Foothills	0.1	4.4	4.3	3.2	0.5
Foothills	Lower Foothills	2.5	5.3	2.8	4.1	0.4
Grassland	Dry Mixedgrass	4.3	7.9	3.6	6.3	0.8
Grassland	Mixedgrass	3.6	7.7	4.1	6.4	0.8
Grassland	Northern Fescue	4.1	6.2	2.1	5.1	0.4
Grassland	Foothills Fescue	4.5	7.5	3.0	5.9	0.6
Parkland	Foothills Parkland	3.9	6.4	2.5	4.9	0.4
Parkland	Central Parkland	3.7	5.7	2.0	4.8	0.3
Parkland	Peace River Parkland	3.5	5.0	1.5	4.3	0.3
Boreal Forest	Dry Mixedwood	1.7	5.4	3.7	3.8	0.9
Boreal Forest	Central Mixedwood	0.6	5.3	4.7	3.0	0.9
Boreal Forest	Lower Boreal Highlands	-0.8	3.6	4.4	1.8	0.9
Boreal Forest	Upper Boreal Highlands	0.0	2.4	2.4	1.3	0.4
Boreal Forest	Athabasca Plain	1.0	3.0	2.0	2.0	0.4
Boreal Forest	Peace-Athabasca Delta	1.1	2.5	1.4	1.9	0.3
Boreal Forest	Northern Mixedwood	-0.7	1.5	2.2	0.8	0.5
Boreal Forest	Boreal Subarctic	-1.1	1.2	2.3	-0.2	0.3
Canadian Shield	Kazan Uplands	0.0	2.3	2.3	0.8	0.4

Mean Daily Temperature °C, November						
Natural Region	**Natural Subregion**	**Minimum**	**Maximum**	**Range**	**Mean**	**Standard Deviation**
Rocky Mountain	Alpine	-13.5	-3.2	10.3	-9.1	1.1
Rocky Mountain	Subalpine	-11.8	-1.7	10.1	-6.8	1.1
Rocky Mountain	Montane	-8.4	-1.2	7.2	-4.0	1.1
Foothills	Upper Foothills	-8.5	-3.6	4.9	-5.7	0.6
Foothills	Lower Foothills	-8.3	-3.6	4.7	-5.8	0.9
Grassland	Dry Mixedgrass	-6.1	-0.8	5.3	-3.4	1.4
Grassland	Mixedgrass	-5.1	-0.8	4.3	-2.6	1.1
Grassland	Northern Fescue	-6.2	-3.8	2.4	-5.0	0.6
Grassland	Foothills Fescue	-4.4	-0.8	3.6	-2.7	1.0
Parkland	Foothills Parkland	-4.0	-1.1	2.9	-3.2	0.6
Parkland	Central Parkland	-7.2	-3.2	4.0	-5.3	0.7
Parkland	Peace River Parkland	-8.6	-5.7	2.9	-7.0	0.6
Boreal Forest	Dry Mixedwood	-12.5	-3.7	8.8	-7.5	2.0
Boreal Forest	Central Mixedwood	-13.8	-4.4	9.4	-8.6	1.8
Boreal Forest	Lower Boreal Highlands	-14.8	-7.5	7.3	-10.5	1.5
Boreal Forest	Upper Boreal Highlands	-12.1	-9.3	2.8	-10.7	0.5
Boreal Forest	Athabasca Plain	-11.6	-9.2	2.4	-10.5	0.5
Boreal Forest	Peace-Athabasca Delta	-11.4	-10.0	1.4	-10.6	0.3
Boreal Forest	Northern Mixedwood	-14.5	-10.9	3.6	-12.5	1.0
Boreal Forest	Boreal Subarctic	-14.9	-11.5	3.4	-13.2	0.7
Canadian Shield	Kazan Uplands	-12.7	-10.1	2.6	-11.8	0.4

Mean Daily Temperature °C, December						
Natural Region	**Natural Subregion**	**Minimum**	**Maximum**	**Range**	**Mean**	**Standard Deviation**
Rocky Mountain	Alpine	-14.2	-7.6	6.6	-12.2	0.9
Rocky Mountain	Subalpine	-13.8	-6.1	7.7	-10.9	1.2
Rocky Mountain	Montane	-13.2	-5.7	7.5	-8.8	1.3
Foothills	Upper Foothills	-12.6	-8.2	4.4	-10.3	0.6
Foothills	Lower Foothills	-14.7	-8.3	6.4	-11.4	1.3
Grassland	Dry Mixedgrass	-13.7	-6.1	7.6	-10.0	1.8
Grassland	Mixedgrass	-11.3	-5.7	5.6	-8.3	1.4
Grassland	Northern Fescue	-13.7	-9.5	4.2	-11.8	1.2
Grassland	Foothills Fescue	-11.2	-5.4	5.8	-8.0	1.7
Parkland	Foothills Parkland	-9.1	-5.6	3.5	-8.2	0.7
Parkland	Central Parkland	-15.3	-8.2	7.1	-12.3	1.3
Parkland	Peace River Parkland	-15.7	-12.5	3.2	-13.9	0.8
Boreal Forest	Dry Mixedwood	-20.3	-8.8	11.5	-14.6	2.4
Boreal Forest	Central Mixedwood	-21.9	-10.1	11.8	-16.0	2.4
Boreal Forest	Lower Boreal Highlands	-21.6	-14.2	7.4	-17.0	1.6
Boreal Forest	Upper Boreal Highlands	-18.8	-15.1	3.7	-17.1	0.8
Boreal Forest	Athabasca Plain	-21.2	-17.5	3.7	-19.3	0.8
Boreal Forest	Peace-Athabasca Delta	-20.9	-18.9	2.0	-19.6	0.4
Boreal Forest	Northern Mixedwood	-21.8	-18.6	3.2	-20.7	0.6
Boreal Forest	Boreal Subarctic	-21.6	-19.1	2.5	-20.3	0.6
Canadian Shield	Kazan Uplands	-22.3	-18.7	3.6	-21.2	0.6

Primary Precipitation Variables

Mean Monthly Precipitation (mm), January						
Natural Region	**Natural Subregion**	**Minimum**	**Maximum**	**Range**	**Mean**	**Standard Deviation**
Rocky Mountain	Alpine	21.0	172.3	151.3	84.1	21.5
Rocky Mountain	Subalpine	19.4	173.9	154.5	59.4	25.1
Rocky Mountain	Montane	15.4	161.3	145.9	37.5	17.9
Foothills	Upper Foothills	16.9	82.2	65.3	31.8	7.8
Foothills	Lower Foothills	16.3	52.6	36.3	30.7	5.8
Grassland	Dry Mixedgrass	10.8	25.2	14.4	18.0	3.1
Grassland	Mixedgrass	12.2	33.2	21.0	21.6	3.3
Grassland	Northern Fescue	11.0	23.9	12.9	18.5	2.1
Grassland	Foothills Fescue	11.2	67.6	56.4	23.8	9.5
Parkland	Foothills Parkland	12.0	104.8	92.8	23.2	15.0
Parkland	Central Parkland	14.1	29.1	15.0	21.8	2.3
Parkland	Peace River Parkland	22.7	38.0	15.3	30.3	4.0
Boreal Forest	Dry Mixedwood	16.7	41.0	24.3	25.8	4.4
Boreal Forest	Central Mixedwood	17.5	44.7	27.2	24.3	4.2
Boreal Forest	Lower Boreal Highlands	18.6	33.5	14.9	25.4	2.3
Boreal Forest	Upper Boreal Highlands	23.2	35.0	11.8	27.6	1.8
Boreal Forest	Athabasca Plain	19.3	27.9	8.6	21.5	1.9
Boreal Forest	Peace-Athabasca Delta	17.9	20.2	2.3	19.0	0.5
Boreal Forest	Northern Mixedwood	17.4	26.4	9.0	22.1	1.9
Boreal Forest	Boreal Subarctic	24.4	33.6	9.2	29.1	1.3
Canadian Shield	Kazan Uplands	18.1	23.4	5.3	20.3	0.8

Mean Monthly Precipitation (mm), February						
Natural Region	**Natural Subregion**	**Minimum**	**Maximum**	**Range**	**Mean**	**Standard Deviation**
Rocky Mountain	Alpine	21.9	161.7	139.8	79.7	20.4
Rocky Mountain	Subalpine	18.5	136.9	118.4	50.4	19.3
Rocky Mountain	Montane	13.5	105.6	92.1	31.0	14.0
Foothills	Upper Foothills	13.9	80.1	66.2	26.7	6.0
Foothills	Lower Foothills	11.6	38.9	27.3	22.4	3.9
Grassland	Dry Mixedgrass	7.4	18.9	11.5	12.6	1.9
Grassland	Mixedgrass	8.0	26.5	18.5	15.0	3.2
Grassland	Northern Fescue	10.2	19.0	8.8	14.6	1.4
Grassland	Foothills Fescue	9.6	52.6	43.0	19.3	8.0
Parkland	Foothills Parkland	10.5	74.0	63.5	19.4	11.0
Parkland	Central Parkland	10.4	21.5	11.1	15.5	2.1
Parkland	Peace River Parkland	19.2	25.0	5.8	22.5	1.2
Boreal Forest	Dry Mixedwood	10.9	29.7	18.8	19.8	3.6
Boreal Forest	Central Mixedwood	11.9	31.4	19.5	18.2	3.1
Boreal Forest	Lower Boreal Highlands	15.8	30.9	15.1	22.6	2.7
Boreal Forest	Upper Boreal Highlands	19.4	31.9	12.5	24.2	3.3
Boreal Forest	Athabasca Plain	13.2	21.2	8.0	15.5	1.7
Boreal Forest	Peace-Athabasca Delta	11.9	14.2	2.3	13.0	0.6
Boreal Forest	Northern Mixedwood	12.0	26.8	14.8	17.7	3.3
Boreal Forest	Boreal Subarctic	20.4	31.3	10.9	26.5	1.6
Canadian Shield	Kazan Uplands	13.1	18.6	5.5	16.3	1.3

Mean Monthly Precipitation (mm), March						
Natural Region	**Natural Subregion**	**Minimum**	**Maximum**	**Range**	**Mean**	**Standard Deviation**
Rocky Mountain	Alpine	23.1	195.8	172.7	93.1	21.5
Rocky Mountain	Subalpine	20.5	160.5	140.0	57.7	16.6
Rocky Mountain	Montane	18.3	86.7	68.4	36.6	10.7
Foothills	Upper Foothills	19.4	90.9	71.5	34.1	5.7
Foothills	Lower Foothills	17.4	48.3	30.9	25.7	3.3
Grassland	Dry Mixedgrass	10.8	27.0	16.2	17.3	3.3
Grassland	Mixedgrass	12.4	40.2	27.8	22.6	5.3
Grassland	Northern Fescue	11.5	24.6	13.1	18.3	2.2
Grassland	Foothills Fescue	13.4	70.3	56.9	28.1	11.6
Parkland	Foothills Parkland	16.7	84.0	67.3	28.9	12.6
Parkland	Central Parkland	12.4	25.8	13.4	19.1	2.1
Parkland	Peace River Parkland	13.6	25.4	11.8	20.4	2.6
Boreal Forest	Dry Mixedwood	12.6	33.2	20.6	20.5	2.6
Boreal Forest	Central Mixedwood	13.6	37.2	23.6	21.6	3.3
Boreal Forest	Lower Boreal Highlands	18.3	37.4	19.1	26.9	3.1
Boreal Forest	Upper Boreal Highlands	24.3	38.7	14.4	30.1	2.4
Boreal Forest	Athabasca Plain	16.0	29.1	13.1	19.4	2.9
Boreal Forest	Peace-Athabasca Delta	13.6	18.0	4.4	15.6	1.0
Boreal Forest	Northern Mixedwood	12.5	33.2	20.7	20.1	5.0
Boreal Forest	Boreal Subarctic	24.7	39.3	14.6	32.2	2.5
Canadian Shield	Kazan Uplands	13.9	21.9	8.0	17.7	1.2

Mean Monthly Precipitation (mm), April						
Natural Region	**Natural Subregion**	**Minimum**	**Maximum**	**Range**	**Mean**	**Standard Deviation**
Rocky Mountain	Alpine	24.8	140.5	115.7	70.9	14.8
Rocky Mountain	Subalpine	21.5	138.0	116.5	52.7	18.0
Rocky Mountain	Montane	21.4	135.0	113.6	49.8	16.6
Foothills	Upper Foothills	24.5	62.1	37.6	35.3	4.5
Foothills	Lower Foothills	19.5	52.0	32.5	26.9	4.4
Grassland	Dry Mixedgrass	16.3	42.6	26.3	26.3	5.3
Grassland	Mixedgrass	20.4	53.7	33.3	33.1	5.6
Grassland	Northern Fescue	15.3	29.2	13.9	21.2	2.4
Grassland	Foothills Fescue	22.8	78.3	55.5	38.5	11.7
Parkland	Foothills Parkland	27.2	96.8	69.6	42.7	12.5
Parkland	Central Parkland	14.7	35.0	20.3	21.1	2.9
Parkland	Peace River Parkland	15.2	26.0	10.8	21.0	3.0
Boreal Forest	Dry Mixedwood	12.6	38.4	25.8	20.5	2.8
Boreal Forest	Central Mixedwood	12.5	36.7	24.2	21.9	4.3
Boreal Forest	Lower Boreal Highlands	14.9	37.4	22.5	22.2	3.9
Boreal Forest	Upper Boreal Highlands	17.9	29.8	11.9	24.7	2.5
Boreal Forest	Athabasca Plain	16.2	31.5	15.3	20.9	3.7
Boreal Forest	Peace-Athabasca Delta	12.8	19.5	6.7	16.2	1.7
Boreal Forest	Northern Mixedwood	11.1	23.9	12.8	16.1	3.3
Boreal Forest	Boreal Subarctic	19.6	29.3	9.7	24.8	1.8
Canadian Shield	Kazan Uplands	12.0	24.7	12.7	17.0	1.7

Mean Monthly Precipitation (mm), May

Natural Region	Natural Subregion	Minimum	Maximum	Range	Mean	Standard Deviation
Rocky Mountain	Alpine	36.7	121.8	85.1	74.5	13.2
Rocky Mountain	Subalpine	36.2	113.4	77.2	67.0	13.3
Rocky Mountain	Montane	33.2	113.3	80.1	67.7	14.3
Foothills	Upper Foothills	45.1	85.8	40.7	65.6	6.5
Foothills	Lower Foothills	36.2	82.8	46.6	57.9	7.8
Grassland	Dry Mixedgrass	30.5	65.9	35.4	40.7	5.4
Grassland	Mixedgrass	36.7	73.5	36.8	51.4	5.4
Grassland	Northern Fescue	32.5	57.2	24.7	41.6	4.4
Grassland	Foothills Fescue	47.3	92.2	44.9	62.5	9.0
Parkland	Foothills Parkland	52.6	104.4	51.8	67.0	9.1
Parkland	Central Parkland	34.1	68.0	33.9	44.9	5.1
Parkland	Peace River Parkland	28.3	43.1	14.8	37.0	2.7
Boreal Forest	Dry Mixedwood	28.3	72.0	43.7	41.9	6.7
Boreal Forest	Central Mixedwood	27.9	66.6	38.7	42.2	6.6
Boreal Forest	Lower Boreal Highlands	31.3	55.8	24.5	43.4	3.9
Boreal Forest	Upper Boreal Highlands	38.5	57.6	19.1	45.7	3.9
Boreal Forest	Athabasca Plain	22.9	46.7	23.8	33.7	5.5
Boreal Forest	Peace-Athabasca Delta	27.3	38.8	11.5	31.9	1.9
Boreal Forest	Northern Mixedwood	24.7	40.9	16.2	31.2	3.5
Boreal Forest	Boreal Subarctic	34.5	53.4	18.9	44.6	4.7
Canadian Shield	Kazan Uplands	22.7	39.2	16.5	26.9	2.5

Mean Monthly Precipitation (mm), June

Natural Region	Natural Subregion	Minimum	Maximum	Range	Mean	Standard Deviation
Rocky Mountain	Alpine	49.7	135.1	85.4	90.2	9.3
Rocky Mountain	Subalpine	46.5	118.6	72.1	81.6	10.5
Rocky Mountain	Montane	45.4	117.4	72.0	82.1	12.8
Foothills	Upper Foothills	60.9	127.6	66.7	96.4	11.2
Foothills	Lower Foothills	69.9	126.2	56.3	99.3	8.4
Grassland	Dry Mixedgrass	48.2	73.7	25.5	59.9	4.0
Grassland	Mixedgrass	54.6	93.2	38.6	67.4	4.9
Grassland	Northern Fescue	60.1	82.1	22.0	69.3	4.0
Grassland	Foothills Fescue	65.1	101.6	36.5	77.6	6.0
Parkland	Foothills Parkland	74.3	114.3	40.0	88.1	5.1
Parkland	Central Parkland	63.3	92.9	29.6	78.6	5.0
Parkland	Peace River Parkland	61.3	84.2	22.9	72.4	5.0
Boreal Forest	Dry Mixedwood	47.7	104.8	57.1	75.0	11.9
Boreal Forest	Central Mixedwood	45.6	108.7	63.1	74.9	13.6
Boreal Forest	Lower Boreal Highlands	52.2	96.5	44.3	74.5	6.6
Boreal Forest	Upper Boreal Highlands	68.8	91.1	22.3	78.1	4.0
Boreal Forest	Athabasca Plain	43.9	72.1	28.2	55.3	6.4
Boreal Forest	Peace-Athabasca Delta	45.8	54.7	8.9	49.9	1.7
Boreal Forest	Northern Mixedwood	40.8	74.0	33.2	54.8	8.1
Boreal Forest	Boreal Subarctic	61.2	86.3	25.1	70.5	3.5
Canadian Shield	Kazan Uplands	43.6	62.2	18.6	47.6	2.3

Mean Monthly Precipitation (mm), July						
Natural Region	**Natural Subregion**	**Minimum**	**Maximum**	**Range**	**Mean**	**Standard Deviation**
Rocky Mountain	Alpine	44.9	134.2	89.3	89.5	12.5
Rocky Mountain	Subalpine	44.3	122.2	77.9	83.0	16.1
Rocky Mountain	Montane	45.1	100.2	55.1	64.7	12.4
Foothills	Upper Foothills	67.9	137.8	69.9	106.9	11.6
Foothills	Lower Foothills	69.5	134.9	65.4	107.8	12.4
Grassland	Dry Mixedgrass	29.5	69.8	40.3	42.6	8.6
Grassland	Mixedgrass	30.0	63.9	33.9	45.2	5.8
Grassland	Northern Fescue	49.5	83.5	34.0	67.8	6.4
Grassland	Foothills Fescue	36.6	76.0	39.4	54.4	8.5
Parkland	Foothills Parkland	45.7	87.8	42.1	66.1	7.7
Parkland	Central Parkland	57.2	105.8	48.6	83.0	8.7
Parkland	Peace River Parkland	51.9	77.2	25.3	68.8	4.0
Boreal Forest	Dry Mixedwood	51.6	116.7	65.1	80.4	14.2
Boreal Forest	Central Mixedwood	56.7	119.6	62.9	85.2	13.1
Boreal Forest	Lower Boreal Highlands	57.0	116.9	59.9	83.6	10.5
Boreal Forest	Upper Boreal Highlands	74.9	106.6	31.7	92.7	6.3
Boreal Forest	Athabasca Plain	60.8	93.9	33.1	70.5	8.6
Boreal Forest	Peace-Athabasca Delta	57.6	69.6	12.0	63.7	2.5
Boreal Forest	Northern Mixedwood	50.1	73.7	23.6	60.0	4.6
Boreal Forest	Boreal Subarctic	61.5	98.0	36.5	79.4	8.4
Canadian Shield	Kazan Uplands	55.3	81.2	25.9	61.5	2.9

Mean Monthly Precipitation (mm), August						
Natural Region	**Natural Subregion**	**Minimum**	**Maximum**	**Range**	**Mean**	**Standard Deviation**
Rocky Mountain	Alpine	46.8	104.7	57.9	76.1	6.0
Rocky Mountain	Subalpine	46.8	97.3	50.5	72.2	9.1
Rocky Mountain	Montane	39.9	84.7	44.8	63.1	7.7
Foothills	Upper Foothills	57.8	105.1	47.3	83.8	8.6
Foothills	Lower Foothills	58.7	98.8	40.1	80.5	7.2
Grassland	Dry Mixedgrass	28.5	44.7	16.2	35.1	3.1
Grassland	Mixedgrass	32.1	56.3	24.2	42.2	4.4
Grassland	Northern Fescue	35.8	52.8	17.0	45.8	3.6
Grassland	Foothills Fescue	41.8	64.2	22.4	51.7	4.0
Parkland	Foothills Parkland	49.3	68.1	18.8	59.0	3.8
Parkland	Central Parkland	40.9	74.6	33.7	60.0	5.9
Parkland	Peace River Parkland	45.1	69.7	24.6	58.8	6.1
Boreal Forest	Dry Mixedwood	44.9	80.7	35.8	63.7	6.8
Boreal Forest	Central Mixedwood	42.9	89.3	46.4	65.1	7.8
Boreal Forest	Lower Boreal Highlands	45.3	79.5	34.2	65.0	6.4
Boreal Forest	Upper Boreal Highlands	57.8	76.6	18.8	69.3	3.1
Boreal Forest	Athabasca Plain	49.8	72.2	22.4	60.1	5.6
Boreal Forest	Peace-Athabasca Delta	44.1	61.7	17.6	51.9	3.1
Boreal Forest	Northern Mixedwood	39.6	62.9	23.3	48.6	4.8
Boreal Forest	Boreal Subarctic	47.6	66.7	19.1	55.1	4.5
Canadian Shield	Kazan Uplands	42.0	65.8	23.8	48.7	3.4

Mean Monthly Precipitation (mm), September						
Natural Region	**Natural Subregion**	**Minimum**	**Maximum**	**Range**	**Mean**	**Standard Deviation**
Rocky Mountain	Alpine	41.5	112.5	71.0	70.4	9.2
Rocky Mountain	Subalpine	37.7	98.2	60.5	62.9	10.3
Rocky Mountain	Montane	36.1	93.8	57.7	54.9	7.3
Foothills	Upper Foothills	44.7	86.8	42.1	62.5	5.5
Foothills	Lower Foothills	43.6	76.8	33.2	57.3	5.7
Grassland	Dry Mixedgrass	26.8	44.6	17.8	36.4	2.8
Grassland	Mixedgrass	32.5	51.6	19.1	42.4	2.9
Grassland	Northern Fescue	31.5	50.2	18.7	41.1	5.2
Grassland	Foothills Fescue	38.4	73.5	35.1	48.3	4.6
Parkland	Foothills Parkland	47.3	84.0	36.7	54.5	6.0
Parkland	Central Parkland	33.2	58.6	25.4	42.6	5.1
Parkland	Peace River Parkland	31.2	51.3	20.1	41.7	5.2
Boreal Forest	Dry Mixedwood	29.8	68.4	38.6	42.8	6.4
Boreal Forest	Central Mixedwood	33.2	67.9	34.7	46.9	7.1
Boreal Forest	Lower Boreal Highlands	32.5	66.2	33.7	45.8	6.9
Boreal Forest	Upper Boreal Highlands	36.8	56.0	19.2	47.1	3.9
Boreal Forest	Athabasca Plain	39.3	56.7	17.4	46.3	4.7
Boreal Forest	Peace-Athabasca Delta	37.9	56.6	18.7	43.6	3.2
Boreal Forest	Northern Mixedwood	29.2	45.1	15.9	36.3	3.1
Boreal Forest	Boreal Subarctic	36.3	48.5	12.2	42.4	1.8
Canadian Shield	Kazan Uplands	38.0	46.9	8.9	40.1	1.1

Mean Monthly Precipitation (mm), October						
Natural Region	**Natural Subregion**	**Minimum**	**Maximum**	**Range**	**Mean**	**Standard Deviation**
Rocky Mountain	Alpine	28.1	141.3	113.2	78.7	16.3
Rocky Mountain	Subalpine	25.1	121.7	96.6	52.0	15.9
Rocky Mountain	Montane	17.6	97.8	80.2	33.0	7.5
Foothills	Upper Foothills	22.7	75.4	52.7	31.0	5.5
Foothills	Lower Foothills	18.3	45.2	26.9	26.8	3.9
Grassland	Dry Mixedgrass	7.7	18.3	10.6	13.0	2.1
Grassland	Mixedgrass	10.3	26.9	16.6	15.6	2.5
Grassland	Northern Fescue	9.3	20.9	11.6	14.0	1.8
Grassland	Foothills Fescue	13.8	44.4	30.6	20.6	5.1
Parkland	Foothills Parkland	14.5	68.0	53.5	23.8	7.8
Parkland	Central Parkland	9.5	22.5	13.0	16.7	2.1
Parkland	Peace River Parkland	20.1	26.6	6.5	23.7	1.1
Boreal Forest	Dry Mixedwood	12.4	34.5	22.1	23.1	4.4
Boreal Forest	Central Mixedwood	13.7	39.7	26.0	27.5	4.2
Boreal Forest	Lower Boreal Highlands	19.0	43.5	24.5	29.8	4.9
Boreal Forest	Upper Boreal Highlands	23.2	41.8	18.6	33.8	4.6
Boreal Forest	Athabasca Plain	27.2	40.2	13.0	33.7	1.8
Boreal Forest	Peace-Athabasca Delta	26.9	33.2	6.3	30.0	1.8
Boreal Forest	Northern Mixedwood	23.7	36.8	13.1	29.2	3.1
Boreal Forest	Boreal Subarctic	28.3	46.6	18.3	39.3	4.3
Canadian Shield	Kazan Uplands	29.5	38.2	8.7	34.1	1.7

Mean Monthly Precipitation (mm), November

Natural Region	Natural Subregion	Minimum	Maximum	Range	Mean	Standard Deviation
Rocky Mountain	Alpine	185.1	157.3	96.0	23.6	23.65
Rocky Mountain	Subalpine	155.7	134.3	59.1	22.8	22.79
Rocky Mountain	Montane	142.5	126.5	33.0	13.2	13.23
Foothills	Upper Foothills	85.3	67.8	29.0	6.4	6.45
Foothills	Lower Foothills	45.5	28.9	25.2	4.2	4.20
Grassland	Dry Mixedgrass	20.1	12.3	13.6	2.3	2.31
Grassland	Mixedgrass	29.9	21.7	17.3	2.7	2.69
Grassland	Northern Fescue	18.9	8.5	14.0	1.3	1.32
Grassland	Foothills Fescue	58.5	47.5	21.5	8.2	8.19
Parkland	Foothills Parkland	85.4	74.2	21.4	12.3	12.26
Parkland	Central Parkland	21.4	12.5	16.5	1.6	1.60
Parkland	Peace River Parkland	30.4	10.6	26.6	2.6	2.60
Boreal Forest	Dry Mixedwood	34.0	20.5	23.0	4.2	4.23
Boreal Forest	Central Mixedwood	38.1	23.1	24.7	3.6	3.58
Boreal Forest	Lower Boreal Highlands	43.8	22.0	29.6	3.1	3.12
Boreal Forest	Upper Boreal Highlands	39.4	13.4	32.6	2.5	2.47
Boreal Forest	Athabasca Plain	37.5	14.0	28.6	2.7	2.73
Boreal Forest	Peace-Athabasca Delta	27.4	6.7	23.6	1.7	1.65
Boreal Forest	Northern Mixedwood	36.4	18.1	29.3	3.8	3.82
Boreal Forest	Boreal Subarctic	49.3	18.8	39.5	3.1	3.07
Canadian Shield	Kazan Uplands	32.2	9.0	28.3	1.8	1.77

Mean Monthly Precipitation (mm), December

Natural Region	Natural Subregion	Minimum	Maximum	Range	Mean	Standard Deviation
Rocky Mountain	Alpine	20.0	174.8	154.8	86.3	23.0
Rocky Mountain	Subalpine	18.9	174.4	155.5	57.5	25.4
Rocky Mountain	Montane	16.7	157.6	140.9	35.1	15.6
Foothills	Upper Foothills	15.6	83.1	67.5	29.4	7.5
Foothills	Lower Foothills	14.7	46.7	32.0	28.0	4.9
Grassland	Dry Mixedgrass	9.9	25.2	15.3	17.6	2.7
Grassland	Mixedgrass	9.9	34.4	24.5	20.3	4.1
Grassland	Northern Fescue	12.1	24.5	12.4	18.5	2.5
Grassland	Foothills Fescue	12.0	61.1	49.1	23.2	9.0
Parkland	Foothills Parkland	12.1	95.6	83.5	23.0	12.6
Parkland	Central Parkland	14.0	29.2	15.2	21.5	2.0
Parkland	Peace River Parkland	21.3	32.7	11.4	27.1	2.7
Boreal Forest	Dry Mixedwood	13.6	37.7	24.1	24.1	3.4
Boreal Forest	Central Mixedwood	16.3	40.1	23.8	25.0	3.8
Boreal Forest	Lower Boreal Highlands	19.9	34.4	14.5	26.4	2.4
Boreal Forest	Upper Boreal Highlands	23.4	35.1	11.7	28.7	1.7
Boreal Forest	Athabasca Plain	18.3	30.0	11.7	22.6	2.5
Boreal Forest	Peace-Athabasca Delta	16.3	22.1	5.8	18.6	1.4
Boreal Forest	Northern Mixedwood	14.9	29.1	14.2	21.3	3.3
Boreal Forest	Boreal Subarctic	24.0	32.7	8.7	28.9	1.3
Canadian Shield	Kazan Uplands	17.6	25.0	7.4	21.6	1.2

APPENDIX 3. GLOSSARY

The following definitions are primarily from *Terminology of Ecological Land Classification in Canada* (Cauboue et al. 1999) and *Soil and Environmental Science Dictionary* (Gregorich et al. 2001), supplemented by *Glossary of Terms in Soil Science* (Canadian Society of Soil Science 1976).

A horizon	A mineral horizon formed at or near the surface in the zone of removal of materials in solution and suspension, or maximum accumulation of organic carbon, or both.
Ae	A horizon that has been eluviated of clay, iron, aluminum, or organic matter, or all of these.
Ah	A horizon in which organic matter has accumulated as a result of biological activity.
Ap	A horizon markedly disturbed by cultivation or pasture.
abiotic	Describing the nonliving components of an ecosystem; those which affect temperature, moisture, light and nutrient conditions, such as parent materials.
abundance–dominance	This term expresses the number of individuals of a plant species and their coverage in a phytosociological survey. The scale generally used is that of J. Braun-Blanquet from which stemmed many variations. It is based on the coverage of individuals for classes with a coverage higher than 5%, and on the abundance for classes with a lower percentage; frequently, this is also referred to as "cover-abundance". (See Braun-Blanquet method.)
acid igneous rock	Describing igneous rock composed of >66% silica. See igneous rock.
acidic (soil)	Having a pH value of less than 7.0.
active layer	The seasonal thaw zone at the surface of permafrost terrain.
advance regeneration	Young trees under existing stands. Regeneration established before logging, which has survived the logging operation.
aeolian (eolian)	Referring to mineral particles moved and sorted by wind, usually fine sands and coarse silt. (See dune and loess.)
aerobic	Occurring in the presence of oxygen as applied to chemical and biochemical processes; opposite of anaerobic.
aggregate	A group of soil particles cohering in such a way that they behave mechanically as a unit.
albedo	A measurement of reflected energy. Albedo is the coefficient of reflectance, usually applying only to short-wave radiation.
alkaline	Having a pH value of >7.0.
alliance	A vegetation classification level in the Braun-Blanquet system, a collection of associations with similar physiognomy and the same dominant and constant species. (See Braun-Blanquet method.)
alluvium	Mineral material deposited by flowing water, usually sands, silts and gravels.
alpine	The ecological zone that occurs above an elevational tree line, characterized by a distinct climate and vegetation.
anaerobic	Occurring in the absence of oxygen as applied to chemical and biochemical processes.
anthropogenic	Human-made or human-modified materials such that their initial physical properties have been drastically altered.
aquatic	Living or growing in water.

arable land	Land that is cultivated or suitable for cultivation (as opposed to grazing or non-cultivated land).
arctic	The ecological zone north of the latitudinal tree line, characterized by a distinct climate and vegetation.
arid	Describing a soil, climate or region where vegetation may not grow due to a severe lack of water.
aspect	The orientation of a slope face, expressed using a compass direction.
association	(1) A classification level in the Braun-Blanquet system, which is a subdivision of a formation based on floristic composition; an abstract plant community. (2) Sometimes used as a general term for a collection of vegetation stands with similar composition and structure.
avalanche	A form of mass wasting involving snow and ice.
azonal	Vegetation (or soil) that develops on atypical conditions such as flooded or rapidly drained sites.
B horizon	A subsoil horizon characterized by one of: (a) an enrichment in clay, iron, aluminum, or humus (Bt or Bf). (b) a prismatic or columnar structure that exhibits pronounced coatings or stainings associated with significant amounts of exchangeable sodium (Bn or Bnt). (c) an alteration by hydrolysis, reduction, or oxidation to give a change in color or structure from the horizons above or below, or both (Bm).
basal area	The area occupied by a plant near the ground surface; measured across the stem of a tree 1.3 to 1.5 m above the ground surface, or across a clump in the case of graminoids, usually 2 to 3 cm above the ground surface.
bedrock	The solid rock underlying soils and the regolith or exposed at the surface.
bioclimate	All the climatic conditions (climate factors) of a region that have a fundamental influence on the survival, growth and reproduction of living organisms.
biocoenosis	A group of interacting organisms including both plants and animals.
biodiversity	Totality of the richness of biological variation, ranging from within-species genetic variation, through subspecies and species to communities, and the pattern and dynamics of these on the landscape.
Biogeoclimatic Ecosystem Classification (BEC)	A hierarchical ecosystem classification system applied in British Columbia that describes the variation in climate, vegetation and site conditions throughout the province.
biogeoclimatic zone	A level in the British Columbia Biogeoclimatic ecosystem classification system that represents areas with the same regional climate. (See ecoclimatic region, ecoregion and ecological region.)
biogeocoenosis	A group of interacting organisms living together in a particular environment, an ecosystem.
biogeography	A branch of biology or of geography that deals with the geographical distribution of plants and animals.
biomass	The mass of living organisms within a defined space, usually expressed in kg/ha or g/m^2 of dry matter.

biome	Major biotic community composed of all the plants and animals and smaller biotic communities. The smaller communities in a biome possess similarities in gross external appearances (deciduous trees, grasslands, etc.) and gross climatic conditions (desert, tropical, etc.). A particular biome is defined in terms of the characteristic vegetation forms (or life forms).
Biophysical Land Classification	An approach to land classification that combines the physical and biological components of the environment. As the precursor to ecological land classification, the hierarchical classification system originally included four levels. Sometimes the physical components of classification are more heavily weighted than the biological components. The term biophysical was subsequently replaced by "ecological".
biota	The living component of an ecosystem.
biotic	Pertaining to life.
Black (soil)	A soil classification Great Group or Subgroup designation indicating a surface (Ah or Ap horizon) color value darker than 3.5 moist and dry, with a chroma less than 2, dry (grassland or parkland soils with generally greater than 4% organic matter).
bog	Ombrotrophic peatland that is acidic (generally unaffected by nutrient-rich groundwater) and usually dominated by heath shrubs and *Sphagnum* mosses and that may include open-growing, black spruce forest.
boreal	(1) Pertaining to the north. (2) A climatic and ecological zone that occurs south of the subarctic, but north of the temperate hardwood forests of eastern North America, the parkland of the Great Plains region, and the montane forests of the Canadian cordillera.
boulder	Rock fragment over 60 cm in diameter. In engineering, practice boulders are over 20 cm in diameter.
brackish	Water with a salt content between that of fresh and sea water. Brackish water usually has 5-10 parts of salt per thousand.
Braun-Blanquet method	An approach to classifying vegetation that utilizes floristic composition (i.e., characteristic species and associations), developed in central and southern Europe. Includes the Zurich-Montpellier School of Phytosociology.
break of slope	An abrupt change in slope steepness.
broadleaved forest	See deciduous forest.
Brown	A soil classification Great Group or Subgroup designation indicating a surface (Ah or Ap horizon) color value darker than 3.5 moist and 5.5 dry with a chroma less than 3.5 moist (grassland soils with less than about 2% organic matter).
Brunisol	A soil of the Brunisolic Order.
Brunisolic	(1) An Order of soils whose horizons are developed sufficiently to exclude them from the Regosolic Order but lack the degrees or kinds of horizon development specified for soils in other orders. They always have Bm or Btj horizons. The order consists of Melanic, Eutric, Sombric and Dystric Great Groups. (2) A soil classification Subgroup designation indicating the formation of a Bm or Btj horizon within the Ae of a Luvisolic soil (a strongly degraded Luvisol).
bulk density, soil	The mass of dry soil per unit bulk volume.
C horizon	A mineral horizon comparatively unaffected by the pedogenic processes operative in the A and B horizons except for the process of gleying (Cg), or the accumulation of calcium carbonate (Cca) or other salts (Csa). A naturally calcareous C horizon is designated Ck.

C:N ratio	The ratio of the weight of organic carbon to the weight of total nitrogen in a soil or in an organic material.
calcareous soil	Soil containing sufficient calcium carbonate (often with magnesium carbonate) to effervesce visibly when treated with cold 0.1 N hydrochloric acid.
Canadian System of Soil Classification	Hierarchical soil classification system in which the conceptual classes are based upon the generalization of properties of real bodies of soil. Taxa are defined on the basis of observable and measurable soil properties that reflect processes of soil genesis and environmental factors.
Canopy	The more or less continuous cover of branches and foliage formed by the crowns of trees.
canopy closure	The degree of canopy cover relative to openings.
capability	A natural ability to support a selected activity such as agriculture or recreation.
catchment area	See drainage basin.
characteristic species	(1) A diagnostic species used to separate plant community types within the Braun-Blanquet vegetation classification system. (2) Characteristic species may occur in more than *one* community, but are significant (e.g., much more abundant) in only one community. (3) A species with high cover (abundance) and presence.
Chernozem	A soil of the Chernozemic Order.
Chernozemic	An Order of soils that have developed under xerophytic or mesophytic grasses and forbs, or under grassland-forest transition vegetation, in cool to cold, subarid to subhumid climates. The soils have a dark-colored surface (Ah, Ahe or Ap) horizon and a B or C horizon, or both, of high base saturation. The order consists of Brown, Dark Brown, Black and Dark Gray Great Groups.
chroma	A measure of color strength in the Munsell Soil Color Chart.
chronosequence	A chronosequence is a sequence through time. Often, it refers to a secondary successional sequence within a set of plant communities.
classification	The systematic grouping and organization of objects, usually in a hierarchical manner.
classification, soil	The systematic arrangement of soils into categories and classes on the basis of their characteristics. Broad groupings are made on the basis of general characteristics and subdivisions on the basis of more detailed differences in specific properties.
clay	(1) Mineral particles <0.002 mm in diameter. (2) Soil and texture class with approximately a 40 to 60% composition of clay size particles.
climate	The accumulated long-term effects of weather that involve a variety of heat and moisture exchange processes between the earth and the atmosphere. As a particle-size term: a size fraction mm equivalent diameter.
climatic climax	See climax.
climatic index	Number indicating a combination of climatic factors, most often temperature and precipitation, in order to describe the vegetation distribution.

climax	Stable, self-perpetuating vegetation that represents the final stage of succession (89). Climatic climax — Stable, self-perpetuating vegetation developed through succession in response to long-term climatic conditions, as opposed to edaphic climax. Edaphic climax — Stable, self-perpetuating vegetation developed through succession on azonal sites.
cluster analysis	A multidimensional statistical analysis technique used to group samples according to their degree of similarity.
clod	A compact, coherent mass of soil produced by digging or plowing.
coarse fragments	Rock or mineral particles 2.0 mm in diameter.
coarse texture	The texture exhibited by sands, loamy sands and sandy loams, except very fine sandy loam. A soil containing large quantities of these textural classes.
co-dominant	Trees with crowns forming the general level of the main canopy in an even-aged stand of trees. Two plant species of similar stature and cover that occur on the same site.
colluvium	Unconsolidated materials moved by gravity, often occurring at the base of a slope.
community	An assemblage of organisms that interact and exist on the same site.
community type	A group of vegetation stands that share common characteristics, an abstract plant community.
companion species	In phytosociology, a species occurring in several associations with relatively the same frequency, or a species characteristic of another association, but having a lower frequency.
competition	The interaction between organisms resulting from common use of a limited resource. Intraspecific competition occurs within the same species, while interspecific competition arises between different species.
conifer	A cone-bearing plant (except for the Taxaceous family) belonging to the taxonomic group Gymnospermae.
coniferous forest	A plant community with a cover made up of 75% or more conifers.
consistence	The degree of soil cohesion and adhesion based on its resistance to deformation.
consociation	A classification level within the Scandinavian approach to vegetation classification, a collection of sociations with the same dominant species.
constant species	A species occurring more than 80% of the time within a particular plant community type.
constraint	A factor that limits the optimal condition, such as steep slopes or cold temperatures, usually associated with land use capability assessments.
control section	The minimum depth used to classify a soil, usually 1.0 m for mineral soils and 1.6 m for organic deposits.
cordillera	An elongated range of mountains.
corridor	In a landscape, a narrow strip of land that differs from the matrix on either side. Corridors may be isolated strips, but are usually attached to a patch of somewhat similar vegetation.
coulee	A western Canadian term for a steep-sided prairie valley. It may refer to valleys that have a relatively broad bottom, often as a result of a glacial meltwater channel, or to V-shaped gullies caused by more recent erosion.
cover	The area of ground covered with plants of one or more species, usually expressed as a percentage.

cover type	A very general unit of vegetation classification and mapping based on existing plant cover; e.g., closed-canopied deciduous forest, pasture or native prairie.
Cryosol	A soil of the Cryosolic Order.
Cryosolic	An Order of soils formed in either mineral or organic materials that have perennially frozen material within 1 m of the surface in some part of the soil body (or within 2 m if the pedon has been strongly cryoturbated). The mean annual temperature is less than 0°C. The order consists of Turbic, Static or Organic Great Groups based on degree of cryoturbation and the nature of the soil material.
cryoturbation	Churning of the ground surface by frost action.
Cumulic	A soil classification Subgroup designation indicating successive mineral layers that result from deposition of materials (e.g., flood plain deposits).
dbh	The diameter of a tree at breast height. Diameter is measured at 1.3 to 1.5 m above ground surface.
Dark Brown	A soil classification Great Group or Subgroup designation indicating a surface (Ah or Ap horizon) color value darker than 3.5 moist and 4.5 dry with a chroma greater than 1.5, dry (grassland soils with organic matter content in the 2% to 4% range).
Dark Gray	A soil classification Great Group or Subgroup designation indicating a surface (Ah or Ap horizon) color value darker than 3.5 moist and 3.5 to 4.5 dry with a chroma of 1.5 or less (transition forest soils with less than about 2% organic matter).
deciduous	Refers to perennial plants from which the leaves abscise and fall off at the end of the growing season.
deciduous forest	A plant community with a cover made up of 75% or more of deciduous trees. *Syn.* broadleaved forest.
degree-day	A measure of temperature above or below a reference temperature that is generally added up for a certain period. Thus it is a cumulative measurement of the quantity of energy available for growth that makes it possible to compare growth conditions between regions.
delta	Alluvial deposits at the mouth of a river, usually triangular in outline with low relief.
Deposit	See surficial materials.
depression	An area that is lower than the general surrounding landscape, usually less well drained than the surrounding terrain.
diagnostic species	Plant species used to distinguish plant communities based on their presence or absence and on their abundance.
differential species	A diagnostic species that occurs primarily within one or a few plant community types, but that is less abundant and with lower constancy than characteristic species. It may be present in other communities, but with lower abundance and constancy.
diversity	The richness of species within a given area. Diversity includes two distinct concepts: (1) richness of species; (2) eveness in the abundance of the species.
domain	Territory including all the regions having the same vegetation or climatic groups on modal sites.
dominant	A plant with the greatest cover and/or biomass within a plant community. The tallest trees within a forest stand, which extend above the general canopy.
drainage	The removal of excess water from soil as a result of gravitational flow. Soil drainage refers to the frequency and duration of periods when the soil is not saturated. Terms used are excessively, well, moderately, imperfectly and poorly drained.

drainage basin	Area tributary to or draining to a lake, stream, reservoir or other body of water. *Syn.* catchment area. See watershed.
drift	A glacial deposit.
droughty soil	A soil with low water supplying capacity (sandy or very rapidly drained soil).
drumlin	A smooth, elongated hill created by flowing glacial ice. The long axis and tapered end are oriented in the direction of glacial ice flow.
dryland farming	The practice of crop production in low-rainfall areas without irrigation.
duff	A general term for the litter and humus layers of the forest floor.
dune	A low hill or ridge of sand that has been sorted and deposited by wind.
Dystric	A soil classification Great Group designation indicating Brunisolic soils with an acidic solum – a pH (0.01M Ca Cl_2) of less than 5.5 for at least 25 cm starting at the top of the B horizon.
dystrophic	Referring to a physical environment very unbalanced from a nutritive standpoint due to an excess or a significant lack of a mineral or organic element.
ecoclimatic province	A broad complex of ecoclimatic regions that have similar climatic conditions as reflected by vegetation. Examples of such units generally approximate continental climatic zones. See vegetation zone.
ecoclimatic region	An area characterized by a distinctive regional climate as expressed by vegetation. Equivalent to a domain.
ecodistrict	A subdivision of an ecoregion based on distinct assemblages of relief, geology, landform, soils, vegetation, water and fauna. Canadian ecological land classification (ELC) system unit. Scale 1:500 000 to 1:125 000. The subdivision is based on distinct physiographic and/or geological patterns. Originally referred to as a land district. See ecological district.
ecological district	Portion of land characterized by a distinctive pattern of relief, geology, geomorphology and regional vegetation. See ecodistrict.
ecological factor	Element of the site that can possibly influence living organisms (e.g., water available for plants). This term is also frequently used to refer to ecological descriptors.
Ecological Land Classification (ELC)	The Canadian classification of lands from an ecological perspective, an approach that attempts to identify ecologically similar areas. The original system proposed by the Subcommittee on Biophysical Land Classification in 1969 included four hierarchical levels that are currently called ecoregion, ecodistrict, ecosection and ecosite. Ecoprovince and ecoelement were later added to the upper and lower levels of the hierarchy.
ecological range	Interval included between the lower and upper limits of an ecological factor allowing the normal development of a specific organism (or a group of organisms). *Syn.* range of tolerance or ecological amplitude.
ecological region	A region characterized by a distinctive regional climate as expressed by vegetation.
ecological unit	Very general term used to refer to a mapping or classification unit of any rank and based on ecological criteria.
ecology	Science that studies the living conditions of living beings and all types of interactions that take place between living beings on the one hand, and living beings and their environment on the other hand.
ecoprovince	A subdivision of an ecozone that is characterized by major assemblages of landforms, faunal realms, and vegetation, hydrological, soil and climatic zones. Canadian ecological land classification (ELC) system unit.

ecoregion	An area characterized by a distinctive regional climate as expressed by vegetation. Canadian ecological land classification (ELC) system unit. Scale 1:3 000 000 to 1:1 000 000. Originally referred to as a land region. See ecological region and biogeoclimatic zone.
ecosite	(1) A subdivision of an ecosection that consists of an area of land with a particular parent material, having a homogeneous combination of soils and vegetation. A Canadian ecological land classification (ELC) system mapping unit, usually mapped at a scale of 1:50 000 to 1:10 000. Originally referred to as a "land type". (2) In Alberta, ecosite is defined as an area with a unique recurring combination of vegetation, soil, landform and other environmental components.
ecosystem	(1) A complex interacting system that includes all plants, animals, and their environment within a particular area. (2) The sum total of vegetation, animals, and physical environment in whatever size segment of the world is chosen for study. (3) A volume of earth-space that is set apart from other volumes of earth-space in order to study the processes and products of production, particularly those transactions between a community of organisms and its nonliving environment.
ecotone	The transition zone between two adjacent types of vegetation that are different.
ecotype	A group of individuals of the same species that are genetically adapted to local ecological conditions.
ecozone	An area of the earth's surface representing large and very generalized ecological units characterized by interacting abiotic and biotic factors. The most general level of the Canadian ecological land classification (ELC) system.
edaphic	Related to the soil.
edaphic climax	See climax.
edaphic grid	A two-dimensional graphic illustrating the relationship between soil moisture and soil fertility.
edatopic grid	See edaphic grid.
elevational zone	Altitudinal zonation of vegetation.
Elfinwood	See krummholz.
eluviation	The general process of removing, or leaching of, materials from a soil horizon in solution or suspension.
emergent vegetation	Plant species that have a part extending below the normal water level. Such plants are adapted to periodic flooding and include genera such as *Carex, Scirpus,* and *Typha.*
endangered species	Any indigenous species of fauna or flora whose existence in Canada is threatened with immediate extinction throughout all or a significant portion of its range, owing to the actions of humans.
endemic	An organism confined to a certain geographical area.
environment	The summation of all living and nonliving factors that surround and potentially influence an organism.
Eolian	See aeolian.
erosion	The wearing away of the land surface by running water, wind, ice or other geological agents, including such processes as gravitational creep.

Eutric	A soil classification Great Group designation indicating Brunisolic soils with a relatively high degree of base saturation — a pH (0.01M Ca Cl_2) of 5.5 or higher for 25 cm starting at the top of the B horizon.
eutrophic	Refers to nutrient rich status and little or no acid.
evapotranspiration	The combined loss of water by evaporation from the soil surface and by transpiration from plants.
exposure	Location of a site with respect to an environmental factor such as the sun, rain or wind.
fan (alluvial fan)	Unconsolidated materials at the base of a steep slope that were carried and deposited by flowing water; these deposits generally have a conical shape.
fauna	(1) A general term for animals. (2) A list of the animal species present in an area.
fen	A peat-covered or peat-filled wetland with a water table which is usually at or above the surface. The waters are mainly nutrient-rich, minerotrophic waters from mineral soils. The vegetation consists mainly of sedges, grasses, reeds and brown mosses with some shrub cover and at times, a scanty tree layer.
fertility, soil	The status of a soil with respect to the amount and availability of elements necessary for plant growth.
fibric	An organic layer containing large amounts of weakly decomposed material whose origins are readily identifiable.
field guide	A field document with keys to identify a plant community, a forest type or a site from biological and physical criteria. These keys may include complete descriptions of plant communities, forest types or forest sites of the region concerned.
fine texture	Consisting of or containing large quantities of the fine fractions, particularly of silt and clay.
fire climax	Plant community that is maintained by repeated fires.
flark	A Swedish term to designate an elongated, wet and muddy depression in a patterned peatland.
flood plain	An area adjacent to a stream or river, consisting of alluvial sediments, that is periodically inundated during periods of high stream flow.
flora	(1) A general term for plants. (2) A list of the plant species present in an area.
fluvial	Related to stream flow and its associated erosional/depositional processes.
fluvioeolian	Referring to sediments that have been deposited or reworked by both fluvial and aeolian processes; the deposits cannot be separated as either fluvial or aeolian.
fluvioglacial	See glaciofluvial.
fluviolacustrine	Describing lacustrine deposits that have been partially reworked by fluvial processes.
floodplain	The land bordering a stream, built up of sediments from overflow of the stream and subject to inundation when the stream is at flood stage.
fluvial	Material that has been transported and deposited by streams and rivers (also alluvial).
foothills	Low subsidiary hills at the foot of a mountain.
forb	"Forb" is only used for herbaceous plants, and is generally used for broad-leaved herbs, regardless of whether they are monocots or dicots (e.g., *Maianthemum* is a forb).

forest	A relatively large assemblage of tree-dominated stands.
forest floor	Organic layer on soil surface consisting of one or more of L, F and H horizons.
forest region	A major geographical zone characterized by a broadly uniform topography and the same dominant tree species.
forest site	(1) Portion of land whose physical and biological characteristics are sufficiently homogeneous to justify a specific silviculture for a given species, with an expected productivity falling within known limits. (2) Forest planning unit whose bioclimatic, physical and plant characteristics imply some given silvicultural potential and constraints.
forest site type	Summary and synthesis of the characteristics of similar forest sites grouped according to topographic and geomorphological location, nature of soil, floristic composition and vegetation dynamics, etc. It is a classification unit but is often used to name a portion of an area as well as a typological unit.
forest type	An assemblage of forest sample plots with similar floristic composition, forest productivity, and site properties. See vegetation type and association.
forest typology	Study and classification of forest site (or forest types) according to growing sites, composition and stand evolution.
formation	(1) A regional vegetation zone composed of plants with similar physiognomy and environmental conditions. (2) A primary unit of bedrock in stratigraphy.
friable	A consistency term pertaining to the ease of crumbling of soils.
frost-free period	Season of the year between the last frost of spring and first frost of fall.
genotype	The genetic constitution of an individual that may be transmitted.
geomorphology	The study of landforms and their origin.
glaciation	The formation, movement and recession of glaciers or ice sheets.
glacier	A mass of ice that develops as a result of snow and ice accumulation over a long period of time, and which moves laterally from the centre of accumulation.
glaciofluvial	Pertaining to the meltwater streams. flowing from wasting glacier ice and especially to the deposits and landforms produced by streams; relating to the combined action of glaciers and streams.
glaciolacustrine	Pertaining to or characterized by glacial and lacustrine conditions. Said of deposits made in lakes affected by glacier ice or by meltwaters flowing directly from glaciers.
Gleysol	A soil of the Gleysolic Order.
Gleysolic	An Order of soils developed under wet conditions and permanent or periodic reduction. These soils have low chromas, or prominent mottling, or both, in some horizons. The Order includes Gleysol, Humic Gleysol and Luvic Gleysol Great Groups.
gradient (ecological gradient)	Continuous and regular variation of one or more ecological factors.
graminoid	A plant that is grass-like; the term refers to grasses and plants that look like grasses; i.e., only narrow-leaved herbs; in the strictest sense, it includes plants belonging only to the family *Poaceae*.
grassland	Vegetation consisting primarily of grass species occurring on sites that are arid or at least well drained.

gravel	Rounded rock particles with sizes ranging from 2 mm to 75 mm in diameter.
gravelly	Containing appreciable or significant amounts of gravel.
Gray (soil)	A soil classification Great Group designation indicating a surface (Ae or Ap horizon) color value 5 or higher, dry (forest soils with organic matter content less than 2%).
great group	A subdivision of a soil order having some properties that reflect differences in the strength of soil-forming processes.
ground cover	The overall canopy cover of a plant community without reference to different strata.
groundwater	The subsurface water that is below the water table. That portion of the hydrosphere which at any particular time is either passing through or standing in the soil and the underlying strata, and is free to move under the influence of gravity.
growing degree-days	Accumulated heat units above a threshold temperature of 5°C. See degree-day.
growing season	Number of days where the mean temperature is equal to or above 5°C.
habitat	The place in which an animal or plant lives. The sum of environmental circumstances in the place inhabited by an organism, population or community.
hardwood	A tree with broad leaves such as *Acer*, *Fraxinus*, *Populus*, and *Quercus*.
heath	Uncultivated land generally dominated by shrubs, such as ericaceous ones.
herb (herbaceous)	A nonwoody vascular plant.
hill	A prominence smaller than a mountain, usually <300 m.
hilly	Large landform elements with local relief in the 200 to 500 m range. This includes foothills, dissected plateaus and major uplands.
horizon	The basic unit of soil classification that is a horizontal layer of mineral or organic material having differentiated characteristics as a result of soil-forming processes.
hue	One of the three variables of color. A color or shade of color in the Munsell Soil Color Chart such as red, green or blue.
humic	An organic layer of highly decomposed material containing little fibre.
humification	The processes by which organic matter decomposes to form humus.
hummocky	A landform characterized by a complex surface of low- to moderate-relief (local relief generally less than 10 m) knolls and mounds of glacial sediments separated by irregular depressions, all of which lack linear or lobate forms (also called knob and kettle). Slopes are generally less than 0.8 km with gradients of greater 5% to 30%.
humus	A general term for partially or completely decomposed plant litter; well decomposed organic matter.
humus form	Group of soil horizons located at or near the surface of a pedon, which have formed from organic residues, either separate from, or intermixed with, mineral materials.
hydromorphic soil	A general term for soils that develop under conditions of poor drainage in marshes, swamps, seepage areas or flats.
hydrophyte	A plant growing in water. In some cases, only the inflorescence lives out of the water.
ice-contact deposit	Deposits that occur when in contact with ice, such as kames and eskers.
igneous rock	A type of rock that forms from the solidification of magma.
immature soil	A soil with indistinct or only slightly developed horizons.

impeded drainage	A condition which hinders the movement of water through soils under the influence of gravity.
impervious	Resistant to penetration by fluids or by roots.
indicator species	Species, usually plants, used to indicate an ecological condition such as soil moisture or nutrient regime that may not be directly measured.
insolation	Radiant energy received from the sun.
inventory	The systematic survey, sampling, classification and mapping of natural resources.
irrigation	The artificial application of water to the soil for the benefit of growing crops.
isohyet	Lines of equal precipitation.
isotherm	Lines of equal temperature.
kame	A conical hill or irregular ridge of sand and gravel that was deposited in contact with glacier ice.
karst	Surface and subsurface features created by the dissolving of soluble rock such as limestone or gypsum, which results in such features as caverns and sinkholes.
kettle	A depression created by the melting of glacial ice that was buried in moraine.
key	A taxonomic tool used to identify unknown objects (e.g., plants or plant communities) through the use of paired questions.
krummholz	Scrubby, stunted growth form of trees, often forming a characteristic zone at the limit of tree growth in mountains.
lacustrine	Material deposited in lake water and later exposed; sediments generally consisting of stratified fine sand, silt and clay.
landform	(1) A topographic feature. (2) The various shapes of the land surface resulting from a variety of actions such as deposition or sedimentation, erosion and earth crust movements.
landscape	(1) All the natural features such as fields, hills, forests, water, etc., which distinguish one part of the earth's surface from another part. Usually that portion of land or territory which the eye can comprehend in a single view, including all its natural characteristics. (2) A heterogeneous land area composed of a cluster of interacting ecosystems that are repeated in similar form throughout. Landscapes can vary in size, down to a few kilometers in diameter.
landscape ecology	(1) A study of the structure, function, and change in a heterogeneous land area composed of interacting ecosystems. (2) The scientific basis for the study of landscape units from the smallest mappable landscape cell to the global ecosphere landscape in their totality as ordered ecological, geographical and cultural wholes.
landscape element	The basic, relatively homogeneous, ecological unit, whether of natural or human origin, on land at the scale of a landscape.
layer	See stratum.
leaching	The removal of soluble materials from a soil horizon by percolating water.
level	Refers to land without slope.
limiting factor	Ecological factor that limits the development of an organism by its presence, absence or quantity irrespective of the state of other factors.

lithic	A feature of a soil subgroup which indicates a bedrock contact within the limits of the control section.
litter	The uppermost portion of plant debris on the soil surface, usually not decomposed.
loam	See soil texture. A mixture of sand, silt and clay. It is not related to color.
loess	Material transported and deposited by wind and consisting of predominantly silt-sized particles.
loose	A soil consistency term.
lowland	Extended plains or land that occur below a significantly elevated area.
Luvisol	A soil of the Luvisolic Order.
Luvisolic	An Order of soils that have eluvial (Ae) horizons, and illuvial (Bt) horizons in which silicate clay is the main accumulation product. The soils developed under forest of forest–grassland transition in a moderate to cool climate. The Order includes Gray Brown Luvisol and Gray Luvisol Great Groups (The latter is the most common in western Canada).
macroclimate	Regional climate related to geographical location and relief.
mapping unit	Unit that allows the definition of a geographical reference context.
marsh	A wetland with a mineral or peat substrate inundated by nutrient rich water and characterized by emergent graminoid vegetation.
meadow	A moist area usually dominated by grasses or forbs.
meander	Looped pattern of a stream course.
medium texture	Intermediate between fine textured and coarse textured (soils). It includes the following textural classes: very fine sandy loam, loam, silt loam, and silt.
meltwater channel	A valley-like feature created by flowing water that originated from the melting of glacial ice.
mesic	(1) Describing the sites that are neither humid (hydric) nor very dry (xeric). Average moisture conditions for a given climate. (2) An organic layer of intermediately decomposed material (between that of fibric and humic).
mesoclimate	Macroclimate that undergoes local modifications to many of its elements. The climate of a forest or a slope is a mesoclimate.
mesotrophic	Medium nutrient status and moderately acidic.
metamorphic rock	Rock formed from pre-existant rock after undergoing natural geological processes such as heat or pressure. It differs from the original rock in terms of its physical, chemical or mineral properties.
microclimate	Localized climatic conditions ranging down to conditions at the stand or even individual plant environment level.
mineral soil	A soil that is largely composed of unconsolidated mineral matter.
minerotrophic	Nourished by mineral water. It refers to wetlands that receive nutrients from mineral groundwater in addition to precipitation by flowing or percolating water.
mixedwood	Forest stands composed of conifers and angiosperms each representing between 25 and 75% of the cover.

modal site	A well to moderately well drained site without topographic or edaphic extremes that could reflect the influences of regional climate rather than local site conditions. Also used to describe typical site conditions for an ecosystem unit. See normal, zonal and reference site.
moder	Partially decomposed litter as a result of soil faunal activity, usually not matted.
moderately coarse texture	Consisting predominantly of coarse particles. (In soil textural classification, it includes all the sandy loams except the very fine sandy loam.)
moderately fine texture	Consisting predominantly of intermediate and fine sized particles. (In soil textural classification, it includes clay loam, sandy clay loam, and silty clay loam.)
moisture deficit	A condition that occurs when evaporation and/or transpiration exceeds the available water supply.
moisture regime	Refers to the available moisture supply for plant growth estimated in relative or absolute terms.
mor	Raw plant litter, usually matted, with a distinctive boundary that occurs at the mineral soil surface, in which fungal activity is the primary method of decomposition.
moraine	A mound, ridge, or other distinct accumulation of generally unsorted, unstratified glacial drift, predominantly till, deposited chiefly by direct action of glacier ice, in a variety of topographic landforms that are independent of control by the surface on which the drift lies.
morphology, soil	The physical constitution, particularly the structural properties, of a soil profile as exhibited by the kinds, thickness and arrangement of the horizons and by the structure, consistence and porosity of each horizon.
mountain	Land with large differences in relief, usually refers to areas with more than 600 m of relief.
mull	Decomposed organic matter that has been incorporated with mineral soil; could represent an Ah horizon,
Munsell color system	A color designation system that specifies the relative degree of the three simple variables of color: hue, value, and chroma. For example: IOYR 6/4 is a color with a hue 10-YR, value -6, and chroma -4. These notations can be translated into several different systems of color names as desired. See chroma, hue and value.
Munsell Soil Color Chart	A booklet of standardized color chips used to describe soil horizon colors.
mycorrhiza	The symbiotic association of fungi with the roots of seed plants.
natural province	Vast land mass (of the order of 100 000 km^2) with characteristic features determined by major geological events. There are 3 Natural Provinces recognized in Alberta).
natural region	Extensive land mass (of the order of 20 000 km^2) characterized by permanent geographic boundaries (geological, physiographic, etc.) and a certain uniformity and individuality of climatic, topographical, geomorphological and biological conditions. There are 6 Natural Regions recognized in Alberta.
natural subregion	Large land mass (of the order of 10 000 km^2) characterized by permanent geographic boundaries (geological, physiographic, etc.) and a certain uniformity and individuality of climatic, topographical, geomorphological and biological conditions. There are 21 Natural Subregions recognized in Alberta.
neutral soil	A soil having a pH value of approximately 7.0 in the surface horizons.
niche	A unique habitat or set of conditions that allows a species to exist with minimalcompetition from other species.

nonsoil	Rock, water, snow or ice, mineral or organic material <10 cm thick over rock or soil materials displaced by unnatural processes such as earth fill.
normal site	A site with deep loamy soils, with neither a lack nor an excess of soil nutrients, located in well drained positions in the landscape and neither protected from, nor exposed to, local climatic extremes. See zonal, modal and reference site.
nutrient	Usually refers to one of a specific set of primary elements found in soil that are required by plants for healthy growth, such as nitrogen, phosphorus, potassium, calcium, magnesium and sulphur.
nutrient regime	The relative level of nutrient availability for plant growth.
old growth	A stand of mature or overmature trees relatively uninfluenced by human activity.
oligotrophic	A condition of low nutrient status and acidic reaction).
ombrotrophic	An ecological system that derives its nutrients solely (or primarily) from precipitation.
Order	The highest taxonomic level in the Canadian System of Soil Classification, reflecting the nature of soil environment and the effects of dominant soil-forming processes.
Organic	(1) An Order of soils that have developed dominantly from organic deposits. The majority of organic soils are saturated for most of the year, unless artificially drained. The Great Groups include Fibrisol, Mesisol, Humisol and Folisol. (2) A soil classification Great Group designation indicating a Cryosolic soil formed in organic materials (e.g., a bog with permafrost).
organic matter	The decomposition residues of biological materials derived from: (a) plant and animal materials deposited on the surface of the soils; and (b) roots and micro-organisms that decay beneath the surface of the soil.
Orthic	A soil classification Subgroup designation indicating the usual or typical (central concept) for the Great Group.
outcrop	Exposure of bedrock at the ground surface.
outwash	Materials washed from a glacier by flowing water and laid down as stratified sorted beds. Generally, it is made up of stratified sand and/or gravel.
overstory	The uppermost continuous layer of a vegetation cover; e.g., the tree canopy in a forest ecosystem or the uppermost layer of a shrub stand.
paralithic	Poorly consolidated bedrock which can be dug with a spade when moist. It is severely constraining but not impenetrable to roots.
parent material	The unconsolidated and more or less chemically unweathered material from which soil develops by pedogenic processes.
parkland	Relatively open forest at both low and high elevations — very open in nature.
particle size	The size of a mineral particle as measured by sedimentation, sieving or micrometric methods. Also referred to as grain size.
patterned ground	A general term for circles, polygons, strips, nets and steps created by frost action.
peat	An accumulation of partially decomposed plant matter under saturated conditions.
peatland	A general term for peat-covered terrain.
Peaty	A soil classification phase designation indicating an accumulation of 15 cm to 40 cm of surface peat (15-60 cm if fibric).

ped	A unit of soil structure such as a prism or granule, which is formed by natural aggregates.
pedogenesis	The mode of origin of the soil, especially the processes or soil-forming factors responsible for the development of the solum.
pedology	The aspects of soil science dealing with the origin, morphology, genesis, distribution, mapping and taxonomy of soils.
pedon	A real unit of soil, the smallest homogenous, three-dimensional unit that can be considered a soil.
percolation, soil water	The downward movement of water through soil; especially, the downward flow of water in saturated or nearly saturated soil at hydraulic gradients of the order of 1.0 or less.
periglacial	Said of the processes, conditions, areas, climates and topographic features at the immediate margins of former and existing glaciers and ice sheets, and influenced by the cold temperature of the ice. Permafrost is a periglacial process.
permafrost	Land that has a permanently frozen subsoil.
pH	A measure of acidity or alkalinity of a solution, based on hydrogen ion concentration.
phase	Judged to meaningfully subdivide the unit, especially for management purposes. The phase is not a formal category in the taxonomy.
phenotype	The observable structural and functional properties of an organism that derive from the interaction between its genotype and its environment.
physiognomy	The general appearance of vegetation by broadly defined life forms, such as forest or grassland.
physiographic region	Topographically similar landscapes with similar relief, structural geology and elevation at a mapping scale of 1:1 000 000 to 1:3 000 000.
physiographic subregion	A subdivision of a physiographic region based on distinct patterns of relief, geology and geomorphology, and drainage pattern and density at a mapping scale of 1 :250 000 to 1:1 000 000.
physiography	The study of the genesis and evolution of land forms.
pioneer species	Plant species that initially invade a newly exposed surface.
plain	A relatively large, level, featureless topographic surface.
plant community	A concrete or real unit of vegetation or a stand of vegetation.
plateau	An elevated area with steep-sided slopes and a relatively level surface.
platy	Consisting of soil aggregates that are developed predominately along the horizontal axes, laminated; flaky.
plot	A vegetation sampling unit used to delineate a fixed amount of area for the purpose of estimating plant cover, biomass or density. Plots can vary in their dimensions depending on the purpose of the study and the individual researcher.
population	A group that includes all possible members of a species in a territory at a given time.
postglacial	Occurring after glaciation.
potential	General evaluation of the possible biological productivity or carbon production potential of a site resource (or an area) usually expressed in terms of values to an appropriate management regime. It may be generally established or estimated from site components that represent a permanent character (e.g., soil quality).

potential climax	The species or plant community that will form the climax vegetation on a site. The existing species or plant association may be different from the potential climax due to site disturbance and successional stage.
prairie	An extensive area of native upland grass with a semi-arid to arid climate.
precipitation	A collective term for snowfall and rainfall.
primary succession	See succession.
pristine	An undisturbed natural condition.
productivity	A measure of the physical yield of a particular crop. It should be related to a specified management. Merchantable wood volume productivity is generally expressed in m^3/ha/yr. It may be further subdivided into types (gross, net, primary) or allocations (leaves, wood, above ground, below ground).
profile, soil	A vertical section of the soil through all its horizons and extending into the parent material.
proglacial	Pertaining to all observable phenomena on the face of a glacier or just beyond its ablation area.
quadrat	A vegetation sampling unit with specific dimensions and shape.
rare species	Any indigenous species of fauna or flora that, because of its biological characteristics, or because it occurs at the fringe of its range, or for some other reasons, exists in low numbers or in very restricted areas of Canada but is not a threatened species.
reaction, soils	The degree of acidity or alkalinity of soil, usually expressed as a pH value.
reconnaissance	A level of field analysis that involves relatively quick sampling for the purpose of obtaining general information about an area. In some cases, sampling quality may be high, but the intensity of sampling is very low relative to the size of the total area being studied.
reference site	A site that serves as a normal or modal condition, an "average" or benchmark in terms of vegetation, soil and general site conditions. See modal, normal and zonal site.
regeneration	The renewal of a forest crop by natural or artificial means. Also the new crop so obtained. The new crop is generally less than 1.3 m in height.
Rego	A soil classification Subgroup designation indicating a sol profile with little or no B horizon; an AC profile (often caused by erosion truncation).
regolith	The unconsolidated mantle of weathered rock and soil material overlying solid rock.
Regosol	A soil of the Regosolic Order.
Regosolic	An Order of soils having no horizon development or development of the A and B horizons insufficient to meet the requirements of the other orders. Included are Regosol and Humic Regosol Great Groups.
relief	The difference between extreme elevations within a given area (local relief).
remote sensing	The gathering and interpretation of land-based information by indirect methods such as aerial photography or satellite imagery.
residual material	Unconsolidated and partly weathered mineral materials accumulated by disintegration of consolidated rock in place.
residual soil	Soil formed from, or resting on, consolidated rock of the same kind as that from which it was formed and in the same location.
riparian	Refers to terrain, vegetation or simply a position adjacent to or associated with a stream, flood plain or standing waterbody.

rock	A consolidated mass of mineral matter; a general term for stones.
rolling	A landform characterized by a regular sequence of moderate slopes producing a wavelike pattern of moderate relief (20 m to 100 m). Slope lengths are often 1.6 km or greater with gradients usually greater than 5%.
runoff (run-off)	The portion of the total precipitation in an area that flows on the surface of the land, without entering the soil, reaches streams and flows away through stream channels.
saline soil	A nonalkali soil containing soluble salts in such quantities that they interfere with the growth of most crop plants. The conductivity of the saturation extract is greater than 4 dS/m (formerly mmhos/cm), the exchangeable-sodium percentage is less than 15, and the pH is usually less than 8.5.
salinization	The process of accumulation of salts in soils.
sand	Mineral particles with diameters ranging between 0.05 and 2.0 mm.
saprolite	See residual soil.
saturation percentage	The amount of water required to saturate a unit of soil (often correlated with sodicity).
scree	See talus.
secondary succession	See succession.
sedimentary rock	A rock formed from materials deposited from suspension or precipitated from solution and usually more or less consolidated.
seepage	The slow movement of water near the soil surface, often occurring above an impermeable subsoil layer or at the boundary between bedrock and unconsolidated material that is exposed at ground surface, usually occurs downslope of the recharge area.
seral	Recognizably different succession stages along a successional path or sere.
seral stage	See successional stage.
shade tolerant	Plants capable of growing and successfully reproducing beneath the shading canopy of other species.
shield rock	Crystalline Precambrian rock that forms the core of continents.
shrub	A perennial plant usually with a woody stem, shorter than a tree, often with a multi-stemmed base.
shrubland	An area dominated by shrubs, usually individual plants not in contact and with a herbaceous ground cover.
silt	A soil separate consisting of particles between 0.05 to 0.002 mm in equivalent diameter.
site	(1) The place or the category of places, considered from an environmental perspective, that determines the type and quality of plants that can grow there. (2) All the physical elements of a forest site (climate, deposit, drainage, etc.). It is a relatively homogeneous area in its physical permanent conditions.
site index (SI)	An expression of forest site quality based on the height of dominant and co-dominant trees at a specific age.
slope	(1) An inclined surface. (2) The steepness of an inclined surface, measured in degrees or percentages from the horizontal.
slough	A Western Canadian term for a shallow prairie pond that largely disappears in late summer, often with a muddy bottom.

softwood	(1) A coniferous tree such as *Pinus* (pine) or *Picea* (spruce). (2) A forest type with a cover made up of 76 to 100% of conifers.
soil	(1) The unconsolidated mineral material on the immediate surface of the earth that serves as a natural medium for the growth of land plants. (2) Unconsolidated mineral material or organic material >10 cm thick that occurs at the earth's surface and is capable of supporting plant growth. It is also the zone where the biological, physical, and atmospheric components of the environments interact.
soil map	A map showing the distribution of soil types or other soil mapping units in relation to the prominent physical and cultural features of the earth's surface.
soil moisture	Water contained in the soil.
soil profile	A vertical section of the soil through all its horizons and extending into parent material.
soil structure	The combination or arrangement of primary soil particles into secondary compound units or peds. The secondary units are characterized and classified on the basis of size, shape, and degree of distinctness into classes, types and grades, respectively. Common terms for kind of structure are single grain, amorphous, blocky, subangular blocky, granular, platy, prismatic and columnar.
soil survey	The systematic classification, analysis and mapping of soils within an area.
soil zone	A large area dominated by a zonal soil that reflects the influence of climate and vegetation.
solar radiation	See insolation.
Solonetz	A soil of the Solonetzic Order.
Solonetzic	An Order of soils developed mainly under grass or grass–forest vegetative cover in semiarid to subhumid climates. The soils have a stained brownish or blackish solonetzic B (Bn, Bnt) horizon that can be very hard when dry and a saline C horizon. The order includes the Solonetz, Solodized Solonetz and Solod Great Groups.
solum	The upper horizons of a soil in which the parent material has been modified and in which most plant roots are contained. It usually consists of A and B horizons.
species	A group of organisms having a common ancestry that are able *to* reproduce only among themselves.
stand	A collection of plants having a relatively uniform composition and structure, and age in the case of forests.
stand density	A quantitative measure of tree cover on an area in terms of biomass, crown closure, number of trees, basal area, volume or weight.
stand structure	The distribution of trees in a stand or group by age, size or crown classes.
stone	Rock fragment with a diameter ranging from 25 to 60 cm.
story	A horizontal stratum or layer in a plant community; in forest appearing as one or more canopies.
subalpine	A zone in the mountains that occurs below the alpine.
subarctic	A zone immediately south of the arctic characterized by stunted, open-growing spruce vegetation.
subclimax	Successional stage of a plant community preceding the climax.

subgroup	A subdivision of a soil great group, differentiated on the basis of the kind and arrangement of horizons that indicate conformity to the central concept of the great group, intergrading towards soils of another order, or other special features.
subsoil	A general term referring to the underlying part of the soil itself and that is often considered as being located under the A horizon.
substrate	The medium on which a plant grows.
succession	The progression within a community whereby one plant species is replaced by another until a stable assemblage for a particular environment is attained. Primary succession occurs on newly created surfaces, while secondary succession involves the development or replacement of one stable successional species by another on a site having a developed soil. Secondary succession occurs on a site after a disturbance (fire, cutting, etc.) in existing communities.
successional stage	Stage in a vegetation chronosequence in a given site. *Syn.* seral stage.
surficial materials	Unconsolidated materials that occur on the earth's surface.
swamp	A mineral-rich wetland characterized by a dense cover of deciduous or coniferous trees, or shrubs.
taiga	Refers to a coniferous boreal forest. Often, this term is used to refer to the vegetation zone of transition between boreal forest and tundra. This vegetal formation corresponds to a forest-tundra.
talus	A collection of fallen disintegrated material that has formed a pile at the foot of a steep slope.
terrace	Relatively level benches that are created and occur adjacent to streams or rivers, sometimes sharp or low breaks occur between individual terrace surfaces. These features are formed during a period of fluvial stability followed by a period of down cutting by a stream.
terrain	See topography.
terrestrial	Pertaining to land as opposed to water.
Terric	A soil classification Subgroup designation indicating a mineral substrate within 40 cm to 140 cm of the surface (shallow peat).
texture	The relative proportions of sand, silt and clay (the soil separates) and coarser materials in a mineral sample. It is described in terms such as sand, loamy sand, sandy loam, loam, silt loam, clay loam, silty clay loam and clay that are often grouped into classes according to specific needs (fine texture, medium texture, moderately coarse texture, etc.).
threatened species	Any indigenous species of fauna or flora that is likely to become endangered in Canada if the factors affecting its vulnerability are not reversed.
till (glacial till)	Unstratified drift, deposited directly by a glacier without being reworked by meltwater.
topography	The physical features of an area such as land shape and relief.
toposequence	A sequence of related soils that differ one from the other primarily because of topography and its influence on soil-forming processes. The relationship between soil and vegetation types, primarily a response to different relief.
tree	A woody plant usually with a single main stem.
treeline	The uppermost elevation or northern limit of tree growth, usually on upland sites.
tundra	A level to undulating, treeless plain characteristic of arctic or alpine regions. For most of the year, the mean monthly temperature is below the freezing point.

undergrowth	[sous-bois] *(for)*All the shrubs, herbaceous plants and mosses growing under a canopy.
understory	Vegetation growing beneath taller plants such as trees or tall shrubs.
undulating	A landform with a regular sequence of gentle slopes producing a wavelike pattern of low local relief. Slopes are generally less than 0.8 km long with gradients of less than 5%.
uneven-aged	Of a forest, stand or forest type in which intermingling trees differ markedly in age.
upland	(1) A general term for an area that is elevationally higher than the surrounding area, but not a plateau. (2) An area that is not a wetland and that is also not imperfectly or poorly drained.
valley	Any hollow or low-lying area bounded by hill or mountain ranges, and usually traversed by a stream.
value, colour	One of the three variables of color. A Munsell Soil Color Chart notation that indicates the lightness of a color.
vegetation	The general cover of plants growing on the landscape.
vegetation structure	The vertical stratification associated with a plant community.
vegetation zone	A naturally occurring band of vegetation that occupies a particular environment such as an elevational zone (e.g., subalpine zone).
veneer	A thin layer of unconsolidated material between 10- and 100-cm thick that does not mask the topographic character of the underlying terrain.
Typic	A soil classification Subgroup designation indicating a depth of more than 140 cm of organic material.
von Post humification scale	A manual method for estimating degree of decomposition of peat materials. It is a 10 point scale with assessment based on color of drained water and structure of hand-squeezed material.
vegetation type	(1) An abstract vegetation classification unit, not associated with any formal system of classification. (2) In phytosociology, the lowest possible level to be described. See forest type and association.
water table	The upper surface of groundwater or that level below which the soil is saturated with water.
watershed	All lands enclosed by a continuous hydrologic-surface drainage divide and lying upslope from a specified point on a stream. See drainage basin.
weathering	The physical and chemical disintegration, alteration and decomposition of rocks and minerals at or near the earth's surface by atmospheric agents.
wetland	Land that is saturated with water long enough to promote hydric soils or aquatic processes as indicated by poorly drained soils, hydrophytic vegetation, and various kinds of biological activity that are adapted to wet environments.
wildlife	Natural fauna, usually limited to macro-organisms such as mammals, birds, reptiles and amphibians.
windfall	A tree uprooted or broken off by wind, and areas containing such trees.
xeric	Describes a dry site.
zonal	Describing a soil that reflects the influence of climate and climactic vegetation (e.g., Luvisol).

zonal site	Site with conditions that could potentially support climatic climax plant communities and their associated soils and thus reflect the regional climate. See normal, modal and reference site.
zonation	The natural stratification of the landscape in response to significant area differences

APPENDIX 4. PROPORTIONS (%) OF LANDSCAPE ELEMENTS AND PARENT MATERIALS

Natural Region/ Subregion	Area (km²)	Landscape elements			Parent materials								
		upland	wetland	water	morainal (till)	glacio-lacustrine	glacio fluvial	aeolian	alluv.[1]	colluv.[1] (undiff.)	residual	rock non-soil	organic
Rocky Mountain Natural Region	49,070	94[2]	3	3	50	tr	5	tr	-	20	5	20	-
Alpine	15,084	91	5	4[3]	20	-	-	-	-	15	5	60	-
Subalpine	25,218	96	3	1	55	-	5	-	-	25	10	5	tr
Montane	8,768	95	2	3	65	5	15	5	tr	5	tr	5	-
Foothills Natural Region	66,436	84	15	1	65	5	10	5	tr	tr	5	tr	10
Upper Foothills	21,537	90	10	<1	75	-	5	-	-	5	10	tr	5
Lower Foothills	44,899	79	20	1	60	5	10	5	tr	tr	5	tr	15
Grassland Natural Region	95,565	94	4	2	55	25	10	5	tr	5	tr	-	-
Dry Mixedgrass	46,937	95	3	2	55	20	10	10	tr	5	tr	-	-
Mixedgrass	20,072	94	5	1	40	45	5	5	tr	5	-	-	-
Northern Fescue	14,933	91	6	3	60	20	10	5	tr	5	tr	-	-
Foothills Fescue	13,623	96	3	1	60	30	5	tr	tr	5	tr	tr	-
Parkland Natural Region	60,747	90	8	2	60	20	10	5	tr	5	-	-	-
Foothills Parkland	3,921	96	4	<1	75	25	tr	-	tr	tr	tr	tr	-
Central Parkland	53,706	89	9	2	65	15	10	5	tr	5	tr	-	tr
Peace River Parkland	3,120	92	6	2	tr	75	10	tr	3	12	-	-	tr
Boreal Forest Natural Region	381,046	60	37	3	30	20	10	tr	tr	5	tr	-	35
Dry Mixedwood	85,321	82	15	3	40	30	15	tr	tr	5	-	-	10
Central Mixedwood	167,856	52	45	3	20	25	10	tr	tr	5	-	-	40
Lower Boreal Highlands	55,615	64	35	1	55	5	tr	-	-	5	5	-	30
Upper Boreal Highlands	11,858	64	35	1	55	-	5	-	-	5	5	-	30
Athabasca Plains	13,525	72	25	3	-	-	50	30	tr	tr	-	-	20
Peace-Athabasca Delta	5,535	40	20	40	-	-	-	tr	100	-	-	tr	tr

Northern Mixedwood	29,513	37	60	3	20	10	20	-	-	-	-	tr	50
Boreal Subarctic	11,823	33	65	2	40	-	-	-	-	tr	tr	-	60
Canadian Shield Natural Region	9,719	70	20	10	20	tr	20	-	tr	-	-	45	15
Kazan Upland	9,719	70	20	10	20[4]	tr	20	-	tr	-	-	45	15

1. Alluv. = Alluvium (including recent fluvial materials); colluv. = colluvium, including undifferentiated materials associated with steep valley slopes.
2. Percentages for landscape elements: < 1% are listed as tr (trace), between 1 and 10% are estimated to the nearest 1%;over 10% are estimated to the nearest 5%. Upland % is determined by difference. Percentages for parent materials are estimated to the nearest 5%. Less than 3% is listed as tr (trace).
3. Water in the Alpine Natural Subregion is represented by snow and ice fields.
4. Very coarse textured drift that could be glaciofluvial.

APPENDIX 5. PROPORTIONS (%) OF SOIL TYPES IN THE ROCKY MOUNTAIN AND FOOTHILLS NATURAL REGIONS

Natural Region/ Subregion	Area (km^2)	Diagnostic Soil Classification Categories[1]											
		Black Chernozems	Dark Gray Chernozems & Luvisols[1]	Gray Luvisol	Solonetzic soils and intergrades	Brunisolic Gray Luvisol	Eutric Brunisols	Dystric Brunisols	Gleysols	Organics	Organic Cryosols	Regosols	Non-soil
Rocky Mountain Natural Region	49,070	5	5	10	-	5	25	10	5	tr	-	10	25
Alpine	15,084	-	-	-	-	-	15	5	10	-	-	10	60
Subalpine	25,218	-	-	10	-	15	30	20	5	tr	-	10	10
Montane	8,768	20	20	20	-	-	30	tr	5	-	-	5	tr
Foothills Natural Region	66,436	-	-	40	-	30	5	5	10	10	-	tr	tr
Upper Foothills	21,537	-	-	15	-	55	5	5	15	5	-	tr	tr
Lower Foothills	44,899	-	-	50	-	15	5	5	10	15	-	tr	tr

1. Proportions are estimated to the nearest 5%. Less than 3% is listed as tr (trace).

APPENDIX 6. PROPORTIONS (%) OF SOIL TYPES IN THE GRASSLAND AND PARKLAND NATURAL REGIONS

Natural Region/ Subregion	Area (km²)	Diagnostic Soil Classification Categories[1]										
		Brown Chernozems	Dark Brown Chernozems	Black Chernozems	Solonetzic soils	Dark Gray Chernozems and Luvisols	Gray Luvisols	Gleysols	Regosols	Vertisols	Mesisols	Non-soil
Grassland Natural Region	95,565	30	25	15	15	-	-	5	10	tr	-	tr
Dry Mixedgrass	46,937	60	trr	-	25	-	-	5	10	tr	-	-
Mixedgrass	20,072	5	80	tr	tr	-	-	5	10	-	-	-
Northern Fescue	14,933	tr	60	tr	25	-	-	10	5	tr	-	-
Foothills Fescue	13,623	-	tr	90	tr	-	-	5	5	-	-	tr
Parkland Natural Region	60,747	-	5	60	15	10	tr	10	tr	-	tr	tr
Foothills Parkland	3,921	-	-	80	tr	15	-	5	tr	-	-	tr
Central Parkland	53,706	-	5	60	15	10	tr	10	tr	-	tr	tr
Peace River Parkland	3,120	-	tr	20	15	40	10	10	5	tr	tr	tr

1. Proportions are estimated to the nearest 5%. Less than 3% is listed as tr (trace).

APPENDIX 7. PROPORTIONS (%) OF SOIL TYPES IN THE BOREAL FOREST AND CANADIAN SHIELD NATURAL REGIONS

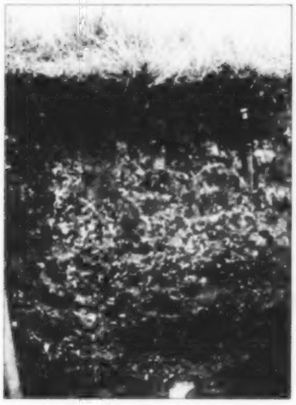
Natural Region/ Subregion	Area (km^2)	Diagnostic Soil Classification Categories[1]											
		Black Chernozems	Dark Gray Chernozems & Luvisols[1]	Gray Luvisol	Solonetzic soils and intergrades	Brunisolic Gray Luvisol	Eutric Brunisols	Dystric Brunisols	Gleysols	Organics	Organic Cryosols	Regosols	Non-soil
Boreal Forest Natural Region	381,046	-	5	35	tr	tr	tr	10	15	30	5	tr	tr
Dry Mixedwood	85,321	-	30	40	5	-	5		10	10	-	tr	tr
Central Mixedwood	167,856	-	tr	35	tr	–	tr	10	15	40	tr	tr	tr
Lower Boreal Highlands	55,615	-	-	55	-	-	tr		15	30	tr	tr	tr
Upper Boreal Highlands	11,858	-	-	50	-	5	tr		15	15	15	tr	tr
Athabasca Plains	13,525	-	-	-	-	10	tr	55	10	20	-	5	tr
Peace-Athabasca Delta	5,535	-	-	tr	-	-	tr		30	tr	-	70	tr
Northern Mixedwood	29,513	-	-	20	-	-	10	10	10	20	30	tr	tr
Boreal Subarctic	11,823	-	-	25	-	-	10	-	10	20	35	-	-
Canadian Shield Natural Region	9,719	-	-	-	-	-	-	35	5	15	tr	tr	45
Kazan Upland	9,719	-	-	-	-	-	-	35	5	15	tr	tr	45

1. Proportions are estimated to the nearest 5%. Less than 3% is listed as tr (trace).

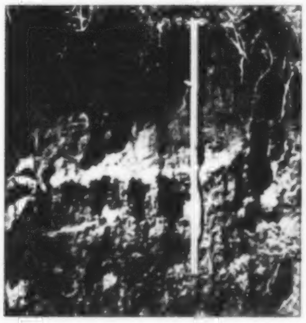
APPENDIX 8. COLOR PLATES

	Description	Credit
Plate 1.	Brown Chernozem	W. Pettapiece
	Dark Brown Solodized Solonetz	Soil Survey Archives
	Rego Dark Brown Chernozem	W. Pettapiece
	Black Chernozem	Soil Survey Archives
	Humic Gleysol	Soil Survey Archives
	Dark Gray Luvisol	Soil Survey Archives
Plate 2.	Orthic Gray Luvisol	Soil Survey Archives
	Orthic Gray Luvisol	W. Pettapiece
	Peaty Humic Gleysol	Soil Survey Archives
	Fibric Mesisol	Soil Survey Archives
	Brunisolic Gray Luvisol	Soil Survey Archives
	Orthic Eutric Brunisol	G. Coen
	Eluviated Dystric Brunisol	Soil Survey Archives
Plate 3.	Glacial till (A)	T. Goddard
	Glacial till (B)	W. Pettapiece
	Glaciolacustrine	W. Pettapiece
	Glaciofluvial	Soil Survey Archives
	Eolian	L. Allen
	Organic	Soil Survey Archives
Plate 4.	Level to undulating	W. Pettapiece
	Undulating with hummocky	W. Pettapiece
	Hummocky	L. Allen
	Rolling and ridged	W. Pettapiece
	Mountain slopes	W. Pettapiece
	Duned	L. Allen
Plate 5.	Slough	L. Allen
	Prairie marsh	W. Pettapiece
	Open sedge fen	Soil Survey Archives
	Wooded fen	L. Allen
	Bog	L. Allen
	Peat plateau	W. Pettapiece
Plate 6.	Arable agriculture	W. Pettapiece
	Irrigation	W. Pettapiece
	Grazing	A. Landals
	Hiking	L. Allen
	Forestry	G. Klappstein
	Oil and Gas	Albert Sustainable Resource Development
	Oil and Gas	W. Pettapiece
	Surface mining	W. Nordstrom
Plate 7.	Water erosion	L. Allen
	Ice and snow	T. Kobliuk
	Fire	Albert Sustainable Resource Development
	Wind erosion and deposition	T. Kobliuk

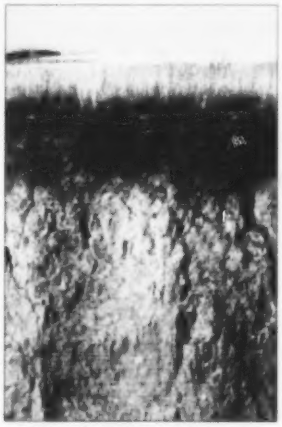
Plate 1. Some Typical Soils in Alberta Prairies and Parkland



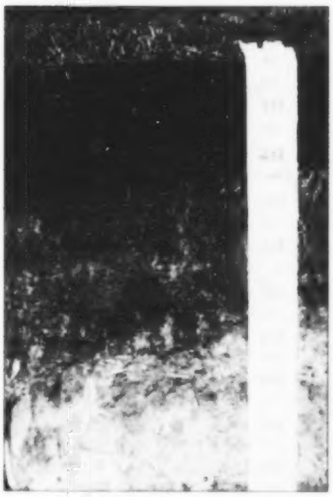
Brown Chernozem
(Mixed Grass)



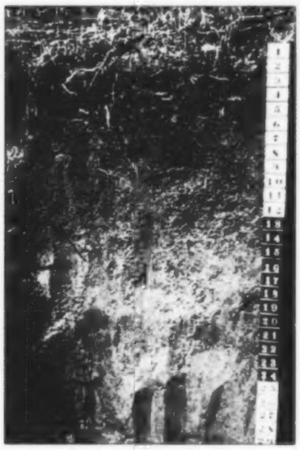
Dark Brown Solodized Solonetz
(Northern Fescue)



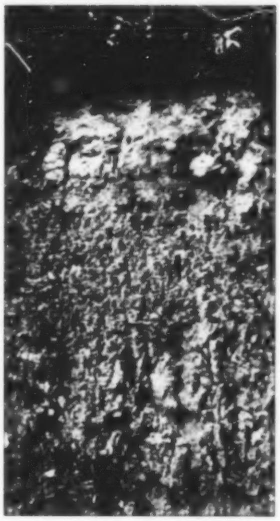
Rego Dark Brown Chernozem
(Thin cultivated soil)



Black Chernozem
(Parkland)

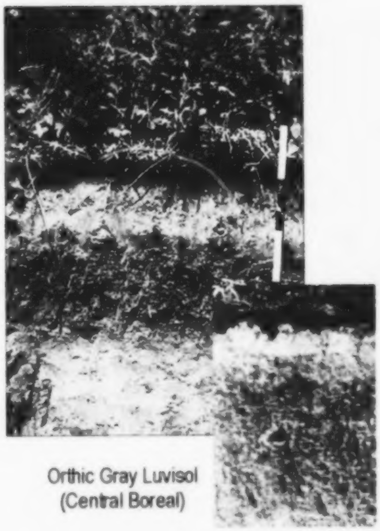


Humic Gleysol
(Parkland)

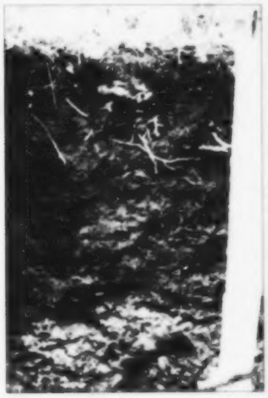


Dark Gray Luvisol
(Parkland)

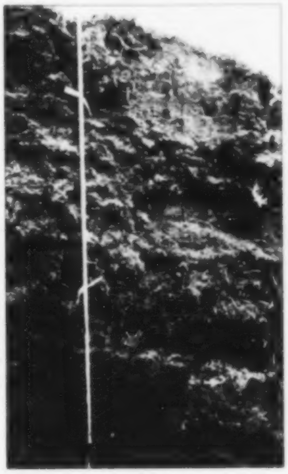
Plate 2. Some Typical Soils In Alberta Boreal and Mountains



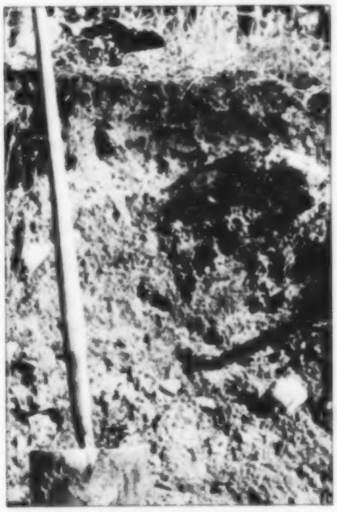
Orthic Gray Luvisol
(Central Boreal)



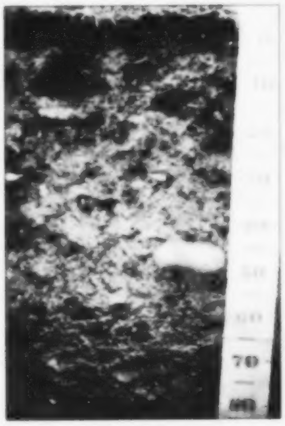
Peaty Humic Gleysol
(Dry Mixedwood)



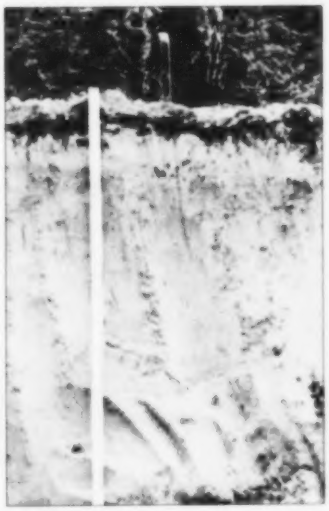
Fibric Mesisol
(Northern Boreal)



Brunisolic Gray Luvisol
(Upper Foothills)

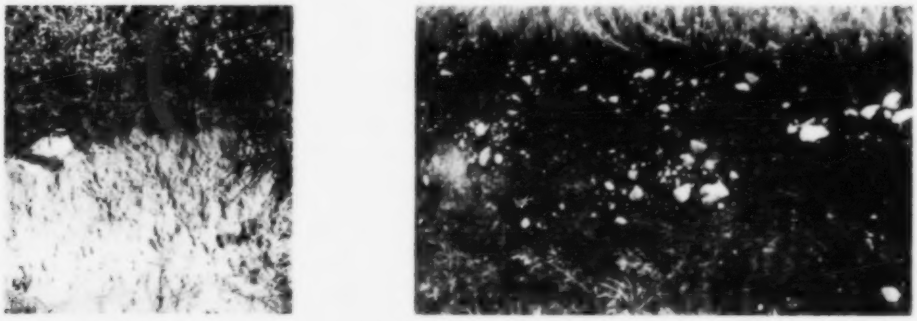


Orthic Eutric Brunisol
(subalpine)

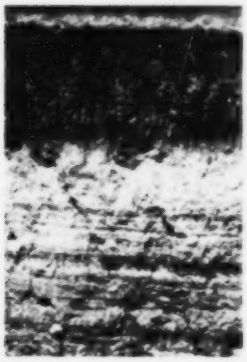


Eluviated Dystric Brunisol
(a forested sandy soil)

Plate 3. Some Typical Surficial Materials In Alberta

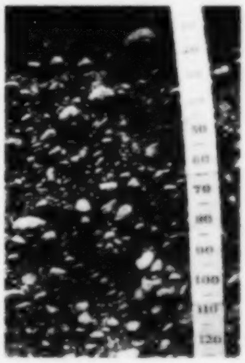


Glacial till is commonly medium textured with included stones (A–left) but it can also be quite stony (B–right), particularly in the mountains.



Glaciolacustrine is common in ice-contact lakes (note the varves and small stones).

Glaciofluvial ranges from silty to very coarse gravely.



Eolian is usually sandy glaciofluvial reworked by wind.

Organic materials accumulate in the cool northern wetlands.

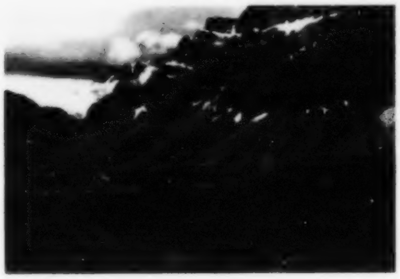
Plate 4. Some Typical Landforms In Alberta — Mineral (Upland) Areas

Level to undulating
(typical glaciolacustrine landforms)

Undulating plain with hummocky upland
(typical morainal landforms of the plains)

Hummocky morainal landscape
(note the abundance of wetlands)

Rolling and ridged
(common to the western uplands and foothills)



Steep mountain slopes
(note the colluvium)

Duned deposits
(stabilized sandy eolian landforms)

Plate 5. Some Typical Landforms In Alberta — Wetlands

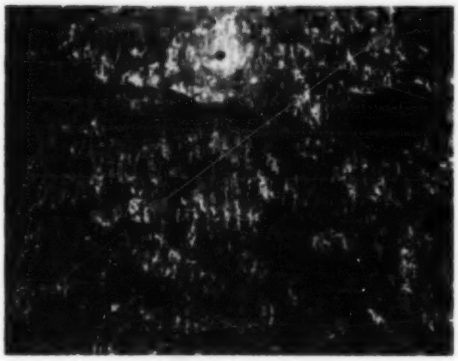
Sloughs
(typical of glaciated plains)

Prairie marsh

Open sedge Fen
(often thin organic soils)

Wooded Fens are common in the Boreal and Foothills areas

Bog
(common in the northern Boreal)



Peat Plateaus
(a permafrost landform common in the Northern Boreal and Subarctic)

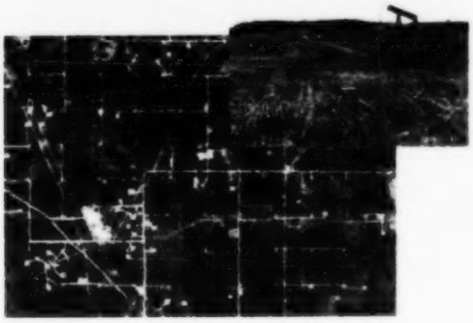
Plate 6. Some Typical Land Uses In Alberta

Arable agriculture is mainly rain-fed
but also includes irrigation in the south

Grazing is common in the Foothills and Plains

Non-invasive landuses such as hiking are also becoming more common

Forest activity occurs in the Boreal and Foothills regions

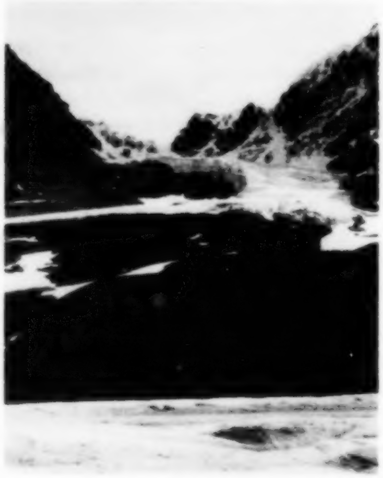


Oil and Gas activity is common throughout the province

Surface mining includes coal, gravel and oil sands
(shown above)

Plate 7. Natural Process that Shape Alberta Ecosystems

Water erosion



Ice and snow

Fire

Wind erosion and deposition